

## Original research

## Do illness rating systems predict discharge location, length of stay, and cost after total hip arthroplasty?

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## ABSTRACT

**Background:** As procedure rates and expenditures for total hip arthroplasty (THA) rise, hospitals are developing models to predict discharge location, a major determinant of total cost. The predictive value of existing illness rating systems such as the American Society for Anesthesiologists (ASA) Physical Classification System, Severity of Illness (SOI) scoring system, or Mallampati (MP) rating scale on discharge location remains unclear. This study explored the predictive role of ASA, SOI, and MP scores on discharge location, lengths of stay, and total costs for THA patients.

**Methods:** A retrospective analysis of patients undergoing elective primary or revision THA was conducted at a single institution. Multivariable regressions were utilized to assess the significant predictive factors for lengths of stay, total costs, and discharge to skilled nursing facilities (SNFs), rehabilitation centers, and home. Controls included demographic factors, insurance coverage, and the type of procedure.

**Results:** ASA scores  $\geq 3$  are the only significant predictors of discharge to SNFs (odds ratio [OR] = 1.69, confidence interval [CI] = 1.04–2.74) and home (OR = 0.57, CI = 0.34–0.98). Medicaid coverage (OR = 2.61, CI = 1.37–4.96) and African-American race (OR = 2.60, CI = 1.59–4.25) were additional significant predictors of discharge to SNF. SOI scores are the only significant predictors of length of stay ( $\beta$  = 1.36 days, CI = 0.53–2.19) and total cost for an episode ( $\beta$  = \$6,234, CI = \$3577–\$8891). MP scores possess limited predictive power over lengths of stay only.

**Conclusions:** These findings suggest that although ASA classifications predict discharge location and SOI scores predict length of stay and total costs, other factors beyond illness rating systems remain stronger predictors of discharge for THA patients.

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## Introduction

After a sharp increase in the rate of total hip arthroplasty (THA) in 2005, annual growth in THA utilization has risen steadily [1,2]. The cost of total joint arthroplasty (TJA) also continues to rise, accounting for 4.6% of all Medicare hospital payments in 2008 [3]. A

primary driver of TJA expenditures is postdischarge cost. Previous literature indicates that postdischarge costs comprise between 35% and 55% of the total payment for an episode [4–6].

Discharge location is a major driver of these postdischarge expenditures. Studies show that anywhere between 29% and 49% of TJA patients are discharged to an extended care facility (ECF) [4,7–11]. Expenditures for ECFs comprise a significant total of postdischarge costs, so optimizing discharge location may control rising THA expenditures [4,12]. Previous literature has attempted to predict discharge location, finding that patient expectations may be the single greatest predictor (odds ratio [OR] = 13–170) of ECF discharge [9,13]. Caregiver support at home is also considered a significant predictor, in addition to the geographic variation among medical centers, which may influence practice styles and patient populations [7,9,14].

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Because patient expectations are difficult to measure, other literature has explored predictive clinical variables. Older age is strongly associated with ECF discharge [7,9,14]. In one study on hip and knee arthroplasties, patients older than 80 years (OR = 20) and patients aged 65-79 years (OR = 8.5) were more likely to be discharged to an ECF than patients under the age of 40 years [7]. Multiple demographic characteristics, including female sex, Medicare coverage, and 3 medical comorbidities (heart disease, diabetes, and chronic obstructive pulmonary disease) were associated with discharge to ECF [6,11]. The influence of revision TJA on discharge location relative to primary procedures remains conflicted [7,14,15].

The predictive value of existing illness rating systems on discharge location, lengths of stay (LOS), and total costs has not been thoroughly assessed. Although some studies suggest a correlation between American Society for Anesthesiologists (ASA) scores and hospital length of stay, other studies have not supported this association [16-19]. Few studies have examined the potentially positive relationship between ASA score and total cost for a THA episode [20,21]. Given its association with patient complications and mortality, ASA ≥3 may also be linked to discharge location [5,18,22-24]. Past research found that ASA class 3 (OR = 3.5) and ASA 4 (OR = 10.8) patients were more likely to be discharged to an ECF [7].

Additional rating systems may have the potential to predict discharge location but are limited by a paucity of supporting evidence. Severity of Illness (SOI) scores, which define the loss of organ system function, may be linked to TJA expenditures and lengths of stay [25-28]. Mallampati scores (MP scores), a preoperative rating system scaled from low (1) to high (4) risk, reflects the difficulty of intubation but has not been investigated as a

predictor of discharge location. If existing illness rating systems can be leveraged to predict discharge location after THA, then care teams can achieve more efficient bed procurement and a reduced hospital length of stay.

The purpose of this study is to explore the predictive role of 3 widely documented illness rating systems—ASA, SOI, and MP scores—in determining discharge location for THA patients treated at a single academic medical center. We also examined the role of each rating system in predicting length of stay and total costs for THA.

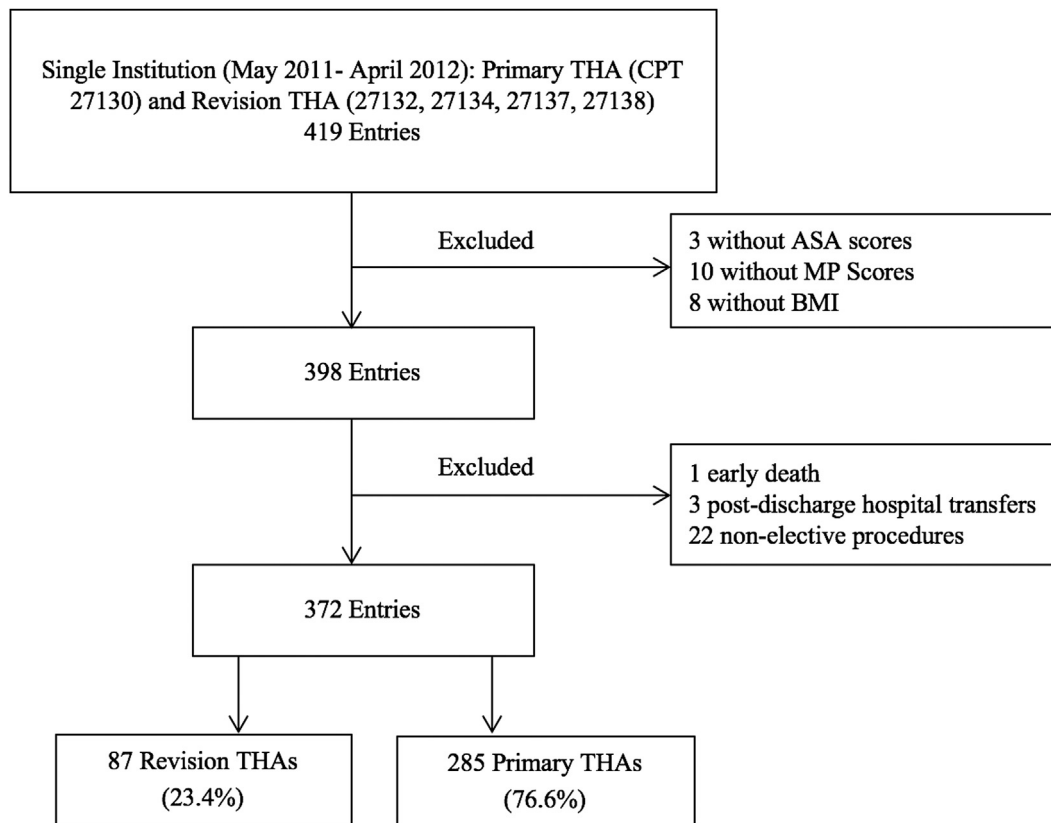
**Material and methods**

*Patient selection*

Patient medical records at a single academic center from May 2011 to April 2012 were retrospectively analyzed. The study cohort included patients with Current Procedural Terminology codes for both primary THA (27130) and revision THA (27132, 27134, 27137, and 27138). A total of 419 records were identified. Patients were excluded for incomplete records, including undocumented ASA score (3), MP score (10), or body mass index (BMI) (8); early postoperative death (1); and discharge to another hospital (3). Nonelective procedures for hip dislocation and periprosthetic fractures that were closed or open reduced (22) were also excluded. A total of 372 complete records were available for analysis (Fig. 1).

*Data organization*

Participants were classified into 3 discharge classes: postacute care in a skilled nursing facility (SNF), postacute care at an acute



**Figure 1.** Selection of THA cohort.

**Table 1**  
Explanation of illness rating systems.

Illness rating system	Scores	Scoring elements
ASA physical status classification system	ASA 1 through ASA 6	1 = healthy person. 2 = mild systemic disease 3 = severe systemic disease 4 = severe systemic disease that is, a constant threat to life 5 = moribund person not expected to survive without operation 6 = brain-dead person serving as an organ donor
SOI scores	Minor, moderate, major, and extreme	The extent of decompensation for an organ system, judged on 7 factors: stage of diagnosis, complications, concurrent interacting conditions, dependency, extent of life support procedures, rate of therapeutic response, and remaining impairment following acute exacerbation
MP Scores	Low (1) to high (4)	Reflects the difficulty of intubation: 1 = soft palate, uvula, fauces, and pillars visible 2 = soft palate, uvula, and fauces visible 3 = soft palate, base of uvula visible 4 = only hard palate visible

rehabilitation facility, or discharge to home. All private insurance plans, including point-of-service plans, preferred provider organizations, health maintenance organizations, traditional plans, and university plans, were analyzed as private insurance. Medicaid and Medicaid Traditional/Indemnity were grouped together as Medicaid. Patients were either denoted as experiencing any postoperative complication or experiencing none. BMI and age were analyzed as continuous variables. Total charges for each 90-day care episode were collected.

**Table 2**  
Demographic distribution.

Factors	Caucasian (n = 192)	African- American (n = 167)	Other (n = 13)	Total (n = 372)
ASA score				
ASA 1	8 4.2%	1 0.6%	1 7.7%	10 2.7%
ASA 2	93 48.4%	80 47.9%	7 53.8%	180 48.4%
ASA ≤2	101 52.6%	81 48.5%	8 61.5%	190 51.1%
ASA 3	87 45.3%	85 50.9%	5 38.5%	177 47.6%
ASA 4	4 2.1%	1 0.6%	0 0.0%	5 1.3%
ASA ≥3	91 47.4%	86 51.5%	5 38.5%	182 48.9%
SOI score				
Major+	30 15.6%	32 19.2%	2 15.4%	64 17.2%
Moderate	88 45.8%	84 50.3%	7 53.8%	179 48.1%
Minor	74 38.5%	51 30.5%	4 30.8%	129 34.7%
MP score				
MP score 1	58 30.2%	49 29.3%	1 7.7%	108 29.0%
MP score 2	95 49.5%	80 47.9%	8 61.5%	183 49.2%
MP score 3	38 19.8%	36 21.6%	4 30.8%	78 21.0%
MP score 4	1 0.5%	2 1.2%	0 0.0%	3 0.8%
Discharge location				
SNF	87 45.3%	114 68.3%	8 61.5%	209 56.2%
Rehab	26 13.5%	18 10.8%	3 23.1%	47 12.6%
Home	79 41.1%	35 21.0%	2 15.4%	116 31.2%
Insurance status				
Medicaid	30 15.6%	54 32.3%	2 15.4%	86 23.1%
Medicare	74 38.5%	76 45.5%	8 61.5%	158 42.5%
Private insurance	88 45.8%	37 22.2%	3 23.1%	128 34.4%
Sex				
Male	105 54.7%	75 44.9%	5 38.5%	185 49.7%
Female	87 45.3%	92 55.1%	8 61.5%	187 50.3%
Anesthesia				
General anesthesia	150 78.1%	135 80.8%	13 100.0%	298 80.1%
Spinal	42 21.9%	32 19.2%	0 0.0%	74 19.9%
Characteristics				
Revision	44 22.9%	38 22.8%	5 38.5%	87 23.4%
Complications	4 2.1%	3 1.8%	1 7.7%	8 2.2%
Average age (yrs)	39.4 ± 13.3	37.1 ± 12.8	41.9 ± 10.7	38.4 ± 13.0
Average BMI	29.3 ± 6.6	30.5 ± 7.2	30.2 ± 10.7	29.9 ± 7.1
Outcomes				
Average LOS (days)	3.7 ± 2.0	3.9 ± 1.7	4.6 ± 2.3	3.8 ± 1.9
Average total cost	\$16507 ± \$6573	\$16513 ± \$5425	\$19082 ± \$9318	\$16600 ± \$6200

Multivariable regressions independently evaluated the impact of each scaling system on discharge location, controlling for age, race, sex, BMI, type of anesthesia administered, revision procedure, and insurance status. Patients were characterized based on ASA scores as ASA ≤2 or ASA ≥3. Only 2 patients were assigned an extreme SOI, so these patients were combined with patients scoring an SOI of major into a single group of major+. The SOI major+ group was then analyzed alongside 2 other groups consisting of moderate or minor SOI scores. Similarly, MP scores of 3 and 4 were combined because only 3 patients (0.8% of the population) scored at the 4 level. Patients were thus grouped into 3 categories for MP scores, encompassing 1, 2, and 3+. An explanation of the components of each illness rating system is explained in [Table 1](#).

*Statistical analysis*

Discharge to SNFs, rehabilitation facilities, and home were analyzed using logit regressions that were then tested via the linktest to ensure choice of meaningful predictors while avoiding specification error. LOS and total costs were analyzed with ordinary least squares robust regression to account for failures in normality, heteroskedasticity, and large residuals. Statistical significance was assessed at an alpha of 0.05. All data analyses were performed using Stata 12.1 statistical software (StataCorp LP, College Station, TX).

**Results**

*Characteristics of the sample*

Demographic information is presented in [Table 2](#). Among the 372 patients examined in the analysis, 192 (51.6%) were Caucasian,

**Table 3**  
Odds ratios for significant risk factors in ASA analysis.

Factor	SNF			Home		
	Odds ratio	P-value	95% CI	Odds ratio	P-value	95% CI
ASA ≥ 3	1.69	.035	1.04-2.74	0.57	.043	0.34-0.98
Spinal	0.47	.011	0.26-0.84	1.99	.034	1.05-3.74
Revision	0.62	.102	0.35-1.10	2.05	.025	1.09-3.83
Medicaid	2.61	.003	1.37-4.96	0.29	.001	0.14-0.58
Medicare	1.02	.939	0.56-1.85	0.65	.194	0.34-1.24
African-American	2.60	<.001	1.59-4.25	0.43	.003	0.25-0.75
Other	1.76	.378	0.50-6.19	0.27	.118	0.05-1.40
Female	1.38	.169	0.87-2.19	0.42	.001	0.25-0.71
Age	1.05	<.001	1.03-1.08	0.95	<.001	0.93-0.98
BMI	1.03	.114	0.99-1.06	0.93	<.001	0.89-0.97

**Table 4**

Odds ratios for independent rating systems and the significant predictive factors of discharge to any care facility.

Predictive factor	Any care facility discharge		
	Odds ratio	P-value	95% CI
ASA $\geq 3$	1.74	.043	1.02-2.98
Major+	2.24	.059	0.97-5.18
Minor	0.58	.073	0.32-1.05
MP Score 2	1.19	.553	0.67-2.13
MP Score 3+	0.75	.408	0.37-1.49
Spinal Anesthesia	0.50	.043	0.27-0.95
Revision	0.49	.025	0.26-0.91
Medicaid	3.47	.001	1.71-7.02
African-American	2.31	.003	1.34-3.98
Female	2.36	.001	1.41-3.94
Age	1.05	<.001	1.02-1.07
BMI	1.08	<.001	1.03-1.12

167 (44.9%) were African-American, and 13 (3.5%) were classified as "other." The pool of patients contained 187 (50.3%) women and 185 (49.7%) men. A majority was classified as either ASA 2 (48.4%) or ASA 3 (47.6%), with only 2.7% as ASA 1 and 1.3% as ASA 4. Most were also classified as moderate (48.1%) on the SOI index, with 17.2% classified as major or higher and the remaining 34.7% classified as minor. Most patients were assigned MP scores of 1 (29.0%) or 2 (49.2%), with only 0.8% assigned the maximum score of 4.

The most common discharge location was SNF (56.2%), followed by home (31.2%), and finally rehabilitation facility (12.6%). Medicare funded 42.5% of the procedures, private insurance covered 34.4%, and Medicaid funded the remaining 23.1%. A majority of patients received general anesthesia (80.1%), with the remaining receiving spinal anesthesia (19.9%). Revisions constituted 23.4% of the procedures.

#### Results for discharge location

Multivariable regressions tested the predictive validity of ASA scores, SOI ratings, and MP scores on discharge to rehabilitation facilities, discharge to SNFs, and discharge to home, as well as on length of stay and total cost of the episode.

Only an ASA score  $\geq 3$  was a significant predictor of discharge to an SNF (OR = 1.69;  $P = .035$ ; 95% confidence interval [CI] = 1.04-2.74) (Table 3). Additional significant positive predictors of discharge to SNF include Medicaid insurance (OR = 2.61;  $P = .003$ ; CI = 1.37-4.96) relative to private insurance and African-American race (OR = 2.60;  $P < .001$ ; CI = 1.59-4.25). Increasing age was also associated with an increased likelihood of discharge to an SNF. In contrast, those receiving spinal anesthesia were less likely to be discharged to an SNF than those receiving general anesthesia. Revisions, Medicare coverage, other race, sex, and BMI were not significant predictors of discharge to an SNF.

ASA scores  $\geq 3$  also predicted a statistically significant reduction in discharge to home (OR = 0.57;  $P = .043$ ; CI = 0.34-0.98). SOI scores, while not statistically significant, may be clinically significant. A score of major or greater was associated with a 55% reduction in home discharge relative to those with moderate scores (OR = 0.45;  $P = .059$ ; CI = 0.19-1.03). Other variables associated with decreased likelihood of discharge home included Medicaid coverage, African-American race, and female sex. Every 1-year increase in age and 1 unit increase in BMI also reduced the likelihood of home discharge. Only revision procedures and spinal anesthesia were significant positive predictors of discharge home.

When SNFs are grouped with rehabilitation facilities to predict discharge to any ECF, ASA scores remained the only significant predictors of discharge location (Table 4). An ASA score  $\geq 3$  was

associated with a 74% increase in discharge to a care facility relative to ASA  $\leq 2$  (OR = 1.74;  $P = .043$ ; CI = 1.02-2.98). Medicaid coverage, African-American race, female sex, increasing age, and increasing BMI were additional significant positive predictors of discharge to any ECF. Revision status and spinal anesthesia remained the only significant predictors of discharge home.

#### Results for LOS and total costs

Among illness rating systems, only SOI scores were significant predictors of both LOS and total costs for a THA episode (Table 5). A rating of major or higher results in an average LOS increase of 1.36 days ( $\beta = 1.36$ ;  $P = .001$ ; CI = 0.53-2.19) relative to those with a moderate SOI. Revision procedures, Medicare coverage relative to private insurance, and female sex were additional significant predictors of increased LOS. Race, age, BMI, and anesthesia type were not significant predictors of LOS.

For total costs, an SOI rating of major or extreme resulted in an average cost increase of \$6234 ( $\beta = \$6234$ ;  $P < .001$ ; CI = \$3577-\$8891). The only other significant predictor of cost was revision procedures, which were associated with an average cost increase of \$3623 ( $\beta = \$3320$ ;  $P = .001$ ; CI = \$1548-\$5698). Age, BMI, race, sex, insurance coverage, and anesthesia type were not significant predictors of total costs.

#### Discussion

Few studies have explored the predictive value of current illness rating scales, including ASA physical status, SOI, and MP scores, on discharge location, LOS, and total costs for an episode. Because postdischarge costs comprise as much as 55% of total expenditure for THA, prediction of discharge location could optimize discharge procedures, lower total lengths of stay, and reduce health-care expenditure [4,9-11]. This is especially valuable at an institution with a high-risk THA population and substantial rates of SNF discharge.

We found that ASA scores are the only rating system serving as a significant predictor of discharge to SNFs and home. This finding is concordant with previous evidence that increasing ASA scores may predict discharge to SNFs [7,29]. When rehabilitation centers and SNFs are combined into all ECFs, ASA scores remain the only significant predictors, with increasing scores associated with greater likelihood of postacute care outside of the home. Interestingly, ASA scores  $\geq 3$  are not significant predictors of length of stay ( $\beta = 0.46$ ;  $P = .010$ ). This finding aligns with previous literature conflicted about the predictive validity of ASA scores for LOS [16-18]. Furthermore, ASA scores were not significant predictors of

**Table 5**

Odds ratios for significant risk factors in SOI analysis.

Factor	LOS (Days)			Cost (dollars)		
	$\beta$	P-value	95% CI	$\beta$	P-value	95% CI
Major+	1.36	.001	0.53 to 2.19	6234	<.001	3577 to 8891
Minor	-0.12	.300	-0.34 to 0.11	-444	.245	-1194 to 306
Spinal	0.14	.427	-0.21 to 0.49	324	.584	-737 to 1385
Revision	1.07	.003	0.37 to 1.76	3623	.001	1548 to 5698
Medicaid	0.23	.207	-0.13 to 0.58	51	.927	-1045 to 1146
Medicare	0.49	.033	0.04 to 0.93	1093	.095	-191 to 2377
African-American	0.06	.310	-0.33 to 0.45	-356	.553	-1535 to 823
Other	0.61	.128	-0.18 to 1.40	1707	.317	-1644 to 5058
Female	0.46	.009	0.11 to 0.80	255	.621	-760 to 1271
Age	0.004	.631	-0.01 to 0.02	13	.620	-38 to 65
BMI	0.003	.818	-0.02 to 0.02	35	.342	-38 to 110



total costs but were positively associated, similar to the previous correlations between ASA scores and costs [20].

This analysis also included SOI and MP scores. SOI scores of major or higher, while not predictive of discharge location, are the only significant predictors of both LOS ( $\beta = 1.36$  days) and total costs ( $\beta = \$6451$ ), a finding that is, supported by the previous literature [25,26,28]. This analysis was the first to explore the predictive value of MP scores. However, only an MP score of 2 was a significant predictor of LOS, with a clinically small increase in LOS relative to scores of 1 ( $\beta = 0.37$  days;  $P = .029$ ;  $CI = 0.04$ – $0.71$ ).

Beyond illness rating systems, the strongest significant predictors of discharge to SNFs were Medicaid coverage ( $OR = 2.61$ ;  $P = .003$ ) and African-American race ( $OR = 2.60$ ;  $P < .001$ ). Previous research found that enrollment in California's state Medicaid program was a significant predictor of ECF discharge, while other reports determined Medicare to be a significant positive predictor ( $OR = 2.21$ ) and Medicaid a nonsignificant positive predictor ( $OR = 1.31$ ) of discharge to ECF [7,11]. However, few studies have incorporated race into their analyses. One found that African-American race was associated with ECF discharge, while another found that minority patients are more likely to be discharged home for self-care than Caucasian patients [11,30]. We found that African-American patients were more likely to be discharged to a SNF than home, but the analysis does not differentiate by the level of care provided at home.

When predicting discharge to all ECFs, Medicaid and African-American race remain significant predictors while sex, age, BMI, spinal anesthesia, and revision status emerge as significant, independent predictors. Our finding that females experience more frequent discharge to ECFs ( $OR = 2.36$ ) is supported by previous studies [7,11,14]. Literature also supports the finding that increasing age is associated with an increase in the risk of discharge to ECFs ( $OR = 1.05$ ) [9,14]. This is the first study to identify increasing BMI ( $OR = 1.08$ ) as a significant, independent predictor.

Spinal anesthesia ( $OR = 0.50$ ) relative to general anesthesia and revision procedures ( $OR = 0.49$ ) relative to primary remained the only significant negative predictors of discharge to ECF. Anesthesia type has never been previously examined as a predictor of discharge location, but spinal anesthesia has been associated with better outcomes after TJA, which may explain increased likelihood of home discharge [31]. Several studies have shown no association between discharge location and revision or an insignificant trend toward home discharge [7,14]. However, one study found that 98% of revision THA patients were discharged home—not a significant difference from primary procedures [15]. Revision procedures for infections may increase discharge to ECFs relative to revisions for mechanical or pain issues, but only 6 of the 87 revisions (6.9%) included in this analysis were for infections [32]. Beyond discharge location, previous research supports the finding that revision THA is associated with increases in LOS and total costs [15,32].

We acknowledge several limitations in the study. First, this was a single institution study incorporating a relatively small sample size with a unique demographic and risk profile. Second, the distribution of patients within each rating system was highly concentrated on moderate values, with only 2.7% scoring ASA 1 and 1.3% scoring ASA 4, so analysis by specific ASA score was limited. Analysis with larger populations, particularly those with greater racial diversity beyond the 3.5% of patients classified in the current cohort as other than Caucasian or African-American, would likely discern greater nuances among the scores. Third, we could not gather information on the patient's living situation, caregiver support, or personal expectations for discharge, which previous literature has deemed influential for postoperative discharge location [9,13,14]. Fourth, some institutions have changed their discharge procedures since the present study's data collection and

analysis. While the strength of conducting the study at 1 academic medical center eliminates geographic variability and pinpoints a unique experience at a high-risk, high SNF discharge institution, caution should be used if generalizing to other regions or community hospitals [7].

## Conclusions

ASA and SOI scores possess some predictive validity for patient outcomes, although they differ in the measures best predicted. ASA scores are stronger at predicting discharge to SNFs and home, while SOI scores are stronger predictors of LOS and total costs. However, additional factors beyond illness rating systems remain the strongest predictors of discharge for THA patients. Additional research should focus on nonclinical factors such as patient expectations and caregiver support while also exploring the association between revision procedures and higher rates of home discharge. Efforts to refine these predictive tools must continue, as accurate prediction of discharge location permits optimization of LOS, total costs, and ultimately patient outcomes.

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