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The development and application of a risk stratification index system for outpatient shoulder arthroscopy patient management—a single academic center's experience

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Background: Our goal was to develop a risk stratification index (RSI) that could guide management of our patients. We hypothesized that the risks of unexpected overstay admission (OS) and emergency department (ED) transfer are predictable on the basis of patient factors for elective outpatient shoulder arthroscopic surgery.
Methods: We first identified 124,860 subjects who received shoulder arthroscopic surgery in the Health-care Cost and Utilization Project database. We next conducted multivariable regression analysis to identify risk factors associated with unanticipated OS or ED transfer. The risk factors were then adopted to construct the RSI. We last applied the RSI into our practice and prospectively collected outcome data between August 2014 and June 2015.
Results: The significant risk factors included arrhythmia, chronic obstructive pulmonary disease, diabetes, obesity, neurologic disease with function impairment, and general anesthesia. All significant risk factors were then adopted to calculate the RSI with equal weight assignment. Simulated analysis concluded that a patient with 2 or fewer risk factors would carry a theoretical rate for OS or ED events of 0.73%. A total of 583 shoulder arthroscopy procedures were performed, among which 472 (81.0%) patients passed the RSI and were successfully managed in the outpatient surgical center without any admission. There were 111 (19.0%) subjects with procedures performed in the main hospital, with 2 unexpected admissions (1.8%).
Conclusion: We developed an RSI tool for shoulder arthroscopic surgery with an existing national database. It is our conclusion that the RSI system is an effective tool to optimize clinical practice. However, over time, a longer follow-up period might provide more convincing evidence.

The general trend of our surgical practice is to shift more surgical procedures into the outpatient surgical setting, while our patients' medical conditions are becoming more and more complicated.[10] This paradox provides a great challenge for freestanding outpatient surgical centers, which lack inpatient service capacity in case of emergency or complications in addition to rigorous state regulation. The effectiveness of such freestanding outpatient practice relies on several aspects, including the selection of patients, the surgeon's skills, the anesthesiologist, the nursing staff, and others. The Centers for Medicare & Medicaid Services require outpatient surgery centers to report the rate of hospital transfer at the time of discharge as a quality metric for ambulatory surgery.[2] It is likely that insurance payments will be bundled into such measures in the near future.[1]

Arthroscopic operations of the shoulder, including rotator cuff repair and labral repair and acromioplasty of anterior to posterior lesions, are among the most commonly performed outpatient orthopedic operations. However, we know little about the rate of hospital transfer after arthroscopic shoulder surgery or the effective risk management of such patients. We conducted a large retrospective study using administrative data from the state of New York. We hypothesized that the risks of hospital transfer and complications are predictable on the basis of patient factors and that

such risks can be evaluated preoperatively to guide our clinical practice for better resource allocation.

Materials and methods

We acquired the New York State Ambulatory Surgery and Services Database (SASD) through the U.S. Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project from 2008 to 2011 (http://www.hcup-us.ahrq.gov). The database includes patient characteristics; demographic information; _International Classification of Diseases, Ninth Revision, Clinical Modification_ diagnosis and procedure codes; discharge status; and admission status (http://www.hcup-us.ahrq.gov/nisoverview.jsp). Arthroscopic shoulder surgical subjects were identified by listed _Current Procedural Terminology_ codes (29805, 29806, 29807, 29819, 29810, 29821, 29822, 29823, 29824, 29825, 29826, 29827, and 29828).

There were 124,863 entries from 2008 to 2011 within New York State's SASD. We eliminated mortality first (n = 3). We next identified patients coded with events of overstay admission (OS) or emergency department (ED) transfer. We then conducted multivariable regression analysis to identify risk factors associated with unanticipated OS or ED. All significant risk factors were included in developing a risk stratification index (RSI) scoring system. Sim-

ulation analysis was conducted to test the RSI system with existing SASD data. We then applied the RSI into our clinical practice for selection of patients and resource designation. The outcome of the RSI practice in our institution was followed up for the next 10 months, and results were reported.

Statistical analysis

All data analyses were executed in Stata 14.1 statistical software (StataCorp LP, College Station, TX, USA). Multivariable logistic regression analysis was used to evaluate risk factors associated with hospital readmissions or ED visits. The RSI scoring system was modeled with equal weight for its simplicity for clinical application.

Results

There were 124,860 valid entries of arthroscopic shoulder surgical procedures between 2008 and 2011 in New York State (Table I). The average age of patients was 48.77 ± 14.67 years. Subjects were predominantly male (59.97%) and white (60.87%). The burden of chronic disease was low in the cohort; 88.97% of patients had a Deyo Comorbidity Index (DCI)[5] score of 0; only 0.22% of patients had a DCI score ≥3.

Table I
Patient demographic information

		Total		Successfully discharged		OS or ED group		P value
		No. or average	% or SD	No. or average	% or SD	No. or average	% or SD	
Total subjects		124,860		123,920		940		
Age, y		48.77	14.67	48.75	14.67	51.32	14.07	<.0001
Gender	Male	74,884	59.97	74,381	60.02	503	53.51	<.0001
	Female	49,920	39.98	49,483	39.93	437	46.49	
Race	White	76,006	60.87	75,265	60.74	741	78.83	<.0001
	Black	11,668	9.34	11,637	9.39	31	3.30	
	Hispanic	9,584	7.68	9,571	7.72	13	1.38	
	Asian or Pacific Islander	3,212	2.57	3211	2.59	1	0.11	
	Native American	1,785	1.43	1,785	1.44	0	0.00	
	Other	19,328	15.48	19,198	15.49	130	13.83	
Deyo Comorbidity Index	0	111,093	88.97	110,356	89.05	737	78.40	<.0001
	1	11,834	9.48	11,673	9.42	161	17.13	
	2	1,656	1.33	1,618	1.31	38	4.04	
	≥3	277	0.22	273	0.22	4	0.43	
Anesthesia	General	60,524	84.41	59,780	84.27	744	97.77	<.0001
	Regional	11,179	15.59	11,162	15.73	17	2.23	
OR time, min		94.26	59.64	94.3	59.63	89.7	60.83	.0188
OR 2 h		26,424	21.16	26,159	21.11	265	28.19	<.0001
Anemia due to deficiency		101	0.08	98	0.08	3	0.32	.0099
Angina		67	0.05	65	0.05	2	0.21	.0345
Arrhythmia		1,191	0.95	1,167	0.94	24	2.55	<.0001
Blood loss anemia		3	0.00	3	0.00	0	0.00	.8801
Coagulopathy		115	0.09	112	0.09	3	0.32	.0213
Congestive heart disease		192	0.15	184	0.15	8	0.85	<.0001
COPD		6,316	5.06	6,213	5.01	103	10.96	<.0001
Diabetes		6,828	5.47	6,726	5.43	102	10.85	<.0001
Diabetes with complications		127	0.10	126	0.10	1	0.11	.9640
Electrolytes		37	0.03	37	0.03	0	0.00	.5962
Hypertension with complications		147	0.12	144	0.12	3	0.32	.0707
Liver disease		224	0.18	220	0.18	4	0.43	.0735
Lymphoma		56	0.04	55	0.04	1	0.11	.3711
Metastases cancer		6	0.00	6	0.00	0	0.00	.8311
Neurologic disease		528	0.42	513	0.41	15	1.60	<.0001
Obesity		2,576	2.06	2,527	2.04	49	5.21	<.0001
Paralysis		38	0.03	38	0.03	0	0.00	.5913
Peripheral vascular disease		137	0.11	134	0.11	3	0.32	.0516
Pulmonary circulating disease		27	0.02	27	0.02	0	0.00	.6508
Renal disease		165	0.13	161	0.13	4	0.43	.0129
Rheumatoid arthritis		540	0.43	533	0.43	7	0.74	.1432
Solid tumor		91	0.07	91	0.07	0	0.00	.4059
Stroke		128	0.10	125	0.10	3	0.32	.0372
Valve disease		987	0.79	978	0.79	9	0.96	.5618
Weight loss		5	0.00	5	0.00	0	0.00	.8456

_OS_, overstay admission; _ED_, emergency department transfer; _SD_, standard deviation; _OR_, operating room; _COPD_, chronic obstructive pulmonary disease.

Table II
Odds ratios of risk factors for overstay admission or emergency department transfer after shoulder arthroscopy

Risk factors		Odds ratio	95% CI		*P* value	Weight
Require general anesthesia		7.89	4.88	12.78	<.001	1
Age ≥80 y		0.81	0.11	5.84	.833	1
Arrhythmia		1.67	1.02	2.72	.040	1
COPD		1.6	1.26	2.02	<.001	1
Diabetes		1.34	1.06	1.7	.016	1
Neurologic disease with function impairment		2.46	1.34	4.54	.004	1
Obesity	(BMI > 35)	1.85	1.34	2.55	<.001	1
	If BMI > 45					1

CI, confidence interval; *COPD*, chronic obstructive pulmonary disease; *BMI*, body mass index.

Subjects in the hospital transfer group (those who required OS or ED; n = 940) differed from those in the successfully discharged group (n = 123,920). Compared with the discharged group, subjects in the hospital transfer group were older (mean age, 51.32 ± 14.07 years vs. 48.75 ± 14.67 years; *P* < .001), less likely to be male (53.51 % vs. 60.02%; *P* < .001), and more likely to have a higher DCI score (Table I).

Table II summarizes significant risk factors for hospital transfer identified through multivariable regression analysis. Interesting risk factors included arrhythmia, chronic obstructive pulmonary disease (COPD), diabetes, obesity, and neurologic disease with function impairment. Patients who received general anesthesia during the procedure carried the highest odds of requiring hospital transfer (odds ratio, 7.89; 95% confidence interval, 4.88-12.78). A simulated analysis with equal weight assignments on these significant risk factors indicated that rates of hospital transfers were 0.25%, 1.08%, 1.73%, 2.57%, 4.58%, and 16.67%, respectively, for patients with number of risk factors ranging from 0 to 5. There were 98.8% of patients (123,362 of 124,860 patients) with fewer than 2 risk factors and a calculated rate of hospital transfer of 0.73%, and the rate of hospital transfer increased to 2.88% with 3 or more risk factors.

We then developed an RSI system for shoulder arthroscopic patients (Table II). There are 6 risk factors extracted from the regression analysis, including requiring general anesthesia, arrhythmia, COPD, diabetes, obesity, and neurologic disease with function impairment. In addition, we amended it with age older than 80 years and superobesity as additional risk factors based on our clinical experience. We elected to assign equal weight to all risk factors for its simplicity in clinical adoption and application. Patients who scored 2 or below with their corresponding RSIs were eligible to schedule surgery at a freestanding surgical center; for all patients who scored 3 or higher, arrangements were made for surgery at the main hospital location.

A total of 583 outpatient shoulder arthroscopy procedures were performed in our academic center between August 2014 and June 2015. Of these, 472 (81.0%) patients passed the RSI with a risk score of 2 or lower and were successfully managed in the freestanding outpatient surgical center uneventfully. There were 111 (19.0%) patients whose procedures were performed in the main hospital because of either RSI at 3 or above or the surgeon's convenience. There were 2 unexpected admissions (1.8%), which both occurred at the main hospital location.

Discussion

We studied risks of OS and ED transfer for elective outpatient shoulder arthroscopic surgery. In this cohort of patients, 0.75% of patients received hospital-based additional care immediately after elective outpatient arthroscopic shoulder surgery. This hospital-based additional postoperative care included ED transfer (71 of 940

[7.55%]), OS (864 of 940 [91.91%]), or both (5 of 940 [0.53%]). The fact that 91.91% of all events were OS alone illustrated the nonemergent nature of such required patient care in general. The Healthcare Cost and Utilization Project's New York SASD does not include information on the reason for OS or ED. Therefore, we could not explore the underlying reason for these events. Future studies are needed to understand the reason and to highlight potential improvement.

Outpatient surgical centers can be categorized into 2 major types, hospital-based outpatient surgical centers and freestanding surgical centers. The selection of patients, regulatory requirement, types of surgery, and available resources would be different in addition to other factors. Nonetheless, outpatient surgical centers were reputable for their efficiency and effective surgical care for the patients. Any events, including OS and ED, not only could indicate potential poor quality of care to these specific patients but also could significantly disrupt the clinical practice flow of the other patients. The rate of direct hospital transfer is a quality measure of unintended or adverse events as mandated by each individual state, which is usually required to be <1%. Previous studies on ambulatory surgery focused mainly on incidence of hospital admission, procedure-specific risks, organizational structure, and the like.[3,4,8] There are only limited studies focused on patient flow management, such as risk stratification.[7,9,12] Fleisher et al published the milestone perioperative guideline for noncardiac surgery, which has had a profound influence on our clinical practice since 2007.[6] The guideline has been through several revisions with detailed enlisted risk factors, such as history of ischemic heart disease, history of compensated or prior heart failure, history of cerebrovascular disease, diabetes mellitus, and renal insufficiency. However, the guideline focused more on optimization than on risk stratification. It is great for patient care but provides limited guidance for clinical practice in regard to how to optimize clinical practice, especially for these low-risk procedures.

Unexpected disposition after ambulatory shoulder surgery has been previously studied.[11] Memtsoudis et al[11] concluded that risk of unexpected disposition has been decreasing. The risks were associated with a freestanding vs. hospital-based facility and types of anesthesia. However, limited information on comorbidities precluded comment on patient factors. Our study identified several major risk factors of requiring hospital-based additional care immediately after surgery, including arrhythmia, COPD, diabetes, obesity, neurologic disease with function impairment, and general anesthesia. Although the SASD could not provide information on the reason for immediate hospital-based additional care, these significant risk factors in addition to the fact of predominant OS highlighted that the reasons for immediate hospital-based additional care are likely to be related to exacerbation of existing comorbidities in a nonemergent manner. Consistently, general anesthesia might catalyze these comorbidities and therefore presented the highest odds ratio among all risk factors. Whether to optimize these coexisting medical conditions needs to be explored for its influence in reducing the incidence of immediate hospital-based additional care after shoulder arthroscopy surgery. Conversely, hospital-based additional care events may not necessarily translate into poor longer term outcome.

To the best of our knowledge, our study is the first to focus on risks of hospital admission after 1 single type of surgical procedure. Fleisher et al developed an outpatient admission index to predict immediate hospital admission for all outpatient surgery mixture.[7] Their risk factors included age, cardiac diagnoses, cerebrovascular disease, and general anesthesia. These are consistent with our RSI. However, their model also included peripheral vascular disease, malignant disease, human immunodeficiency virus infection, and regional anesthesia. It is understandable that our analysis focused on 1 single type of surgical procedure, and the associated risk factors should be more specific.

Our study has several limitations. First, we focused on a database from New York State. It is not clear how generalizable our results are to other settings or populations of patients. Second, we focused only on reported events within the database. There might be additional immediate postoperative events not recorded in the New York SASD, such as events after discharge. The total number of patients requiring additional care may be further underestimated.

Conclusion

We developed an RSI tool for shoulder arthroscopic surgery with an existing national database. It is our conclusion that the RSI system is an effective tool to optimize clinical practice with safety and efficiency. However, an expanded study period with more subjects might over time provide more convincing evidence.

Disclaimer

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