Cost Determinants in the 90-Day Management of Isolated Ankle Fractures at a Large Urban Academic Hospital

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Objectives: To determine the independent risk factors associated with increasing costs and unplanned hospital readmissions in the 90-day episode of care (EOC) for isolated operative ankle fractures at our institution.

Design: Retrospective cohort study.

Setting: Level I Trauma Center.

Patients: Two hundred ninety-nine patients undergoing open reduction internal fixation for the treatment of an acute, isolated ankle fracture between 2010 and 2015.

Intervention: None.

Main Outcome Measures: Independent risk factors for increasing 90-day EOC costs and unplanned hospital readmission rates.

Results: Orthopaedic (64.9%) and podiatry (35.1%) patients were included. The mean index admission cost was $14,048.65 ± $5,797.48. Outpatient cases were significantly cheaper compared to inpatient cases ($10,164.22 ± $3,899.61 vs. $15,942.55 ± $5,630.85, respectively, $P < 0.001$). Unplanned readmission rates were 5.4% (16/299) and 6.7% (20/299) at 30 and 90 days, respectively, and were often (13/20, 65.0%) due to surgical site infections. Independent risk factors for unplanned hospital readmissions included treatment by the podiatry service ($P = 0.024$) and an American Society of Anesthesiologists score of ≥3 ($P = 0.017$). Risk factors for increasing total postdischarge costs included treatment by the podiatry service ($P = 0.011$) and male gender ($P = 0.046$).

Conclusions: Isolated operative ankle fractures are a prime target for EOC cost containment strategy protocols. Our institutional cost analysis study suggests that independent financial clinical risk factors in this treatment cohort includes podiatry as the treating surgical service and patients with an American Society of Anesthesiologists score ≥3, with the former also independently increasing total postdischarge costs in the 90-day EOC. Outpatient procedures were associated with about a one-third reduction in total costs compared to the inpatient subgroup.

Accepted for publication March 23, 2018.
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The authors report no conflict of interest.
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DOI: 10.1097/BOT.0000000000001186

Key Words: bundled payments, isolated extremity trauma, lower extremity trauma, ankle fractures

(*J Orthop Trauma* 2018;32:338–343)

INTRODUCTION

Ankle fractures currently account for 10% of all fractures.[1] The overall incidence of these injuries has steadily been increasing since the 1970s, demonstrating a bimodal distribution with peaks in populations of younger males and older females.[2] By 2030, the overall ankle fracture incidence in all age groups is expected to triple.[3]

Cost analysis studies in orthopaedics are at the forefront of contemporary literature as we continue the transition into the alternative payment and bundled payment era.[4,5] Although current estimates report an $11 billion economic burden of foot and ankle surgery, little attention has been given to the perioperative cost containment strategies for isolated ankle fractures.[6,7] The limited reports available are either not exclusive to closed, isolated operative injuries[8] or they lack inclusion of postoperative complications and unplanned hospital readmissions.[9] In addition, the most recent studies reporting adverse events and readmission rates after the surgical management of ankle fractures do not include the entire 90-day follow-up period,[6,10] thus underestimating the projected financial impact of these factors in a theoretical bundled payment model.[11] For example, in elective total joint arthroplasty (TJA), postdischarge costs have been tagged with a projected financial accountability range of 36%–55% of the total costs in a given 90-day episode of care (EOC) bundled payment program.[12]

Although the acute surgical management of isolated ankle fractures is an extremely common procedure in orthopaedics, the various risk factors that could significantly impact a simulated bundled payment period are far from delineated. The purpose of this study was 2-fold: first, we sought to determine the clinical variables associated with increasing total costs in a 90-day EOC for the management of isolated ankle fractures requiring surgery at our institution. Second, we calculated the unplanned hospital readmission rates and the associated independent risk factors at 30 and 90 days after discharge from our large urban academic hospital.

PATIENTS AND METHODS

Patient Cohort and Selection Criteria

Before conducting this study, we obtained approval from our Institutional Review Board. Patients undergoing open reduction internal fixation for the treatment of an acute, isolated ankle fracture between 2010 and 2015 were identified using our hospital's administrative database and diagnostic procedure codes. All patients included were treated by either the orthopaedic surgery service or the podiatry service. The referred surgical treatment team was determined by a combination of (1) adherence to an on-call referral schedule and (2) emergency department (ED) attending individual referral preference. Subsequent surgical intervention either occurred upon immediate admission to the hospital or from ED referral to the orthopaedic or podiatry clinics with ensuing surgical scheduling through the office.

Exclusion criteria included any concomitant surgical procedures, malunion and nonunion cases, other traumatic injuries to the ipsilateral or contralateral limbs (ie, polytrauma patients), patients with previous surgeries to the affected ankle, open fractures, and all nonoperatively treated cases.

Data Collection

Individual chart reviews were used to collect all relevant patient demographic and clinical variables. Body mass index (continuous variable), insurance type (government-based vs. private), hospital length of stay (continuous variable), American Society of Anesthesiologists physical status scores [ASA scores: "high" (3 or 4) vs. "low" (1 or 2)], tobacco use status, and diabetes mellitus as a comorbidity were all factored into the study. Individual charts were then reviewed for subsequent return(s) to the ED and/or unplanned hospital readmissions within 90 days after discharge. Reasons for readmission were determined by cross-checking the International Classification of Diseases, Ninth Revision diagnosis codes with individual chart reviews.

Chart reviews encompassed the 90-day postdischarge period including standard clinical follow-up visits in the office. Unimalleolar fractures (medial, lateral, or posterior malleolus), isolated syndesmotic injuries requiring surgery, and bimalleolar, bimalleolar equivalent, trimalleolar, and trimalleolar equivalent injuries were included. Injury patterns were identified from the attending surgeon's operative report dictations. To simplify comparison, injuries were divided into 3 separate groups as delineated in Table 1.

Cost Data

Cost data were obtained via our institution's financial department and represent actual payments from insurers to the hospital as calculated from cost-to-charge ratios. Hospital charges and the cost-to-charge ratios at our institution are not influenced by the treating surgical service (orthopaedics vs. podiatry). The EOC aggregate cost analysis included the direct total hospital costs (ie, actual hospital payments) associated with each individual encounter and any subsequent postdischarge costs (ie, actual hospital payments) associated with any returns to the ED and/or any unplanned hospital readmissions within 90 days of the index clinical encounter.

TABLE 1. Ankle Fracture Groups

Group Number	Fracture/Injury Patterns Included
1	Unimalleolar fracture (medial, lateral, or posterior) and isolated syndesmotic injuries
2	Bimalleolar and bimalleolar equivalent
3	Trimalleolar and trimalleolar equivalent

Statistical Analysis

Distribution parameters (mean values, SDs, frequencies, and proportions) were used to describe the study patient samples and cost data. Patient demographics by primary treatment service are compared in Table 2. Cohort characteristics, clinical outcome measures, and cost breakdown comparisons by treatment group are delineated in Tables 3 and 4, respectively.

Univariate analyses were conducted between all clinical variables and the outcomes of hospital readmission at 30 and 90 days and total postdischarge costs. For the final multivariate model, risk factors that demonstrated at least 10 total occurrences in the total sample population and statistically significant different distributions noted by univariate analyses between the readmission and nonreadmission populations at the $P < 0.20$ significance level were included (Table 5). The final multivariate logistic and log-linear regression models were used to evaluate independent risk factors associated with early hospital readmissions and total postdischarge costs, respectively. The adjusted estimates of the likelihood of readmission for each risk factor are demonstrated as odds ratio (OR) and 95% confidence interval (CI) calculations (Table 5). In the final model, we used a $P < 0.05$ as our significance level. Finally, Hosmer–Lemeshow and C-statistics were computed to assess the goodness-of-fit and predictive ability of the model. Data were analyzed using SPSS Statistical Software (IBM Corporation 2012, Somers, NY).

RESULTS

General Cohort Characteristics

In total, 299 cases met inclusion criteria. Ankle injury patterns were divided into 3 groups to facilitate the analysis (Table 1). The average patient age was 43 ± 14 years, and 57.9% (173/299) of patients were female. The majority of patients had government-based insurance at the time of injury (261/299, 87.3%). Patient demographics are listed in Table 2. Ankle injury groups were mostly unimalleolar fractures ("group 1"; 115/229; 39.5%) or bimalleolar-type fracture patterns ("group 2"; 111/229; 37.1%). Over two-thirds (201/229; 67.2%) of cases were performed in the inpatient setting, and the average length of stay was 2.7 ± 2.3 days (Table 3).

The podiatry cohort consisted of 4 surgeons in total, with 2 of the surgeons performing 81.0% (85/105) of the podiatric surgeries. There were 9 total treating orthopaedic surgeons, and the senior author (S.P.H.) treated 71.0% (137/194) of the cases. Collectively, of the 13 total treating surgeons, 8 of the surgeons performed less than 10 total cases each.

In total, follow-up clinical documentation was available for 295 patients (295/299 or 98.7%). These individual charts

TABLE 2. Cohort Characteristics and Demographics by Primary Treatment Service

	Total Cohort	Orthopaedics	Podiatry	P*
Case volume	299	194	105	
Age (y, continuous)	43.0 ± 14.6	42.6 ± 15.5	43.5 ± 12.9	0.053
Gender (n, %)				0.297
Male	126 (42.1)	86 (44.3)	40 (38.1)	
Female	173 (57.9)	108 (55.7)	65 (61.9)	
Race (n, %)				0.375
White	113 (37.8)	76 (39.2)	37 (35.2)	
Black	147 (49.2)	90 (46.4)	57 (54.3)	
Other	39 (13.0)	28 (14.4)	11 (10.5)	
Insurance type (n, %)				0.114
Government-based	261 (87.3)	165 (85.1)	96 (91.4)	
Private	38 (12.7)	29 (14.9)	9 (8.6)	
Diabetes (n, %)				
Yes	33 (11.0)	20 (10.3)	13 (12.4)	
No	266 (89.0)	174 (89.7)	92 (87.6)	
Tobacco use (n, %)				0.121
Yes	130 (43.5)	78 (40.2)	52 (49.5)	
No	169 (56.5)	116 (59.8)	53 (50.5)	
ASA category (n, %)				0.070
High (3 or 4)	65 (21.7)	36 (18.6)	29 (27.6)	
Low (1 or 2)	234 (78.3)	158 (81.4)	76 (72.4)	
BMI (kg/m^2)	30.6 ± 7.4	30.2 ± 7.2	31.3 ± 7.8	0.213

Values are represented as mean and SD for continuous variables (*) and counts (n) and percentages (%) for categorical variables.
**P*-values for associated variable comparison between orthopaedic and podiatry treatment services; statistical significance was set at the $P < 0.05$ significance level.
BMI, body mass index.

were also reviewed for documentation alluding to potential ED visits and/or hospital readmissions at other outside institutions. No reports suggested any additional occurrences that could definitively influence the outcomes data. The remaining 4 patients lacking postoperative office visit documentation consisted of 2 patients from each treatment cohort, and these patients also did not present to our hospital's ED. All 4 patients had unimalleolar ankle fractures. Furthermore, no in-hospital mortalities occurred during this period.

Cost Analysis

The mean index hospital admission cost total (inpatient and outpatient) was on average, $14,048.65 ± $5797.48

TABLE 3. Clinical Variables and Outcomes by Treatment Service

	Total Cohort	Orthopaedics	Podiatry	P†
Case volume	299	194	105	
Ankle injury groups (n, %)				**<0.001**
1	115 (39.5)	46 (23.7)	69 (65.7)	
2	111 (37.1)	93 (47.9)	26 (24.8)	
3	70 (23.4)	55 (28.4)	10 (9.5)	
Patient class (n, %)				**<0.001**
Inpatient	201 (67.2)	147 (75.8)	54 (51.4)	
Outpatient	98 (32.8)	47 (24.2)	51 (48.6)	
Length of stay (d)*	2.7 (2.3)	2.7 ± 2.3	2.6 ± 2.5	0.087
Returns to ED (n, %)	36 (12.0)	17 (8.8)	19 (18.1)	**<0.001**
Unplanned readmissions (n, %)				
30 d	16 (5.4)	2 (1.0)	14 (13.3)	**<0.001**
90 d	20 (6.7)	5 (2.6)	15 (14.3)	**<0.001**
Return to operating room (n, %)	9 (3.0)	2 (1.0)	7 (6.7)	**0.019**

*Values are represented as mean and SD for continuous variables (*) and counts (n) and percentages (%) for categorical variables.
†*P*-values for associated variable comparison between orthopaedic and podiatry treatment services; bold values indicate statistical significance at the $P < 0.05$ significance level.

TABLE 4. Ninety-Day Episode of Care Cost Breakdown by Treatment Service

Average Total Costs*	Total Cohort	Orthopaedics	Podiatry	P†
Index admissions	\$14,048.65 ± \$5,797.48	\$15,381.25 ± \$5,676.18	\$11,586.51 ± \$5,204.21	**<0.001**
Inpatient subgroup‡	\$15,942.55 ± \$5,630.85			**<0.001**‡
Outpatient subgroup‡	\$10,164.22 ± \$3,899.61			
Returns to the ED	\$6,373.59 ± \$5,170.55	\$4,933.76 ± \$4,729.62	\$7,813.41 ± \$5,318.12	**0.015**
Hospital readmissions	\$21,600.55 ± \$2,124.61	\$11,559.17 ± \$9,256.18	\$24,947.68 ± \$2,324.04	0.214
90-day postdischarge	\$9,478.25 ± \$1,716.86	\$3,175.08 ± \$638.96	\$14,380.72 ± \$2,108.03	**0.002**

*Values are represented as mean and SD for continuous variables.
†*P*-values for associated variable comparison between orthopaedic and podiatry treatment services; bold values indicate statistical significance at the $P < 0.05$ significance level.
‡Separate subgroup analysis and associated *P*-value represents statistical significance at the $P < 0.05$ significance level for cost comparison between inpatient and outpatient encounters.

(Table 4). Outpatient cases were significantly cheaper compared to inpatient cases (\$10,164.22 ± \$3899.61 vs. \$15,942.55 ± \$5630.85, respectively, $P < 0.001$).

When factoring in all postdischarge utilization encounters, the 90-day postdischarge costs averaged \$9478.25 ± \$17,168.56 and was significantly higher in patients treated by the podiatry service as opposed to those treated by the orthopaedic service (\$14,380.72 ± \$21,080.34 vs. \$3175.08 ± \$6389.64, respectively, $P = 0.002$) (Table 4). Furthermore, male gender was an independent risk factor for increasing total postdischarge costs in the final multivariate model (Table 5).

Hospital Readmissions

The unplanned readmission rates (URRs) were 5.4% (16/299) and 6.7% (20/299) at 30 and 90 days, respectively (Table 3). Independent risk factors for 30- and 90-day hospital readmission included treatment by the podiatry service (30-day: OR = 2.37, 95% CI = 0.72–4.01, $P = 0.005$; 90-day: OR = 1.70, 95% CI = 0.50–2.88, $P = 0.005$) and an ASA score ≥3 (30-day: OR = 1.38, 95% CI = 0.19–2.58, $P = 0.024$; 90-day: OR = 1.34, 95% CI = 0.242–2.44, $P = 0.017$) (Table 5). In addition, reasons for readmission were infection and/or wound-related complications in 65.0% (13/20) of the encounters. Other reasons for hospital readmission included exacerbation of preexisting medical conditions (5/20, 25.0%) and trauma admissions unrelated to the primary procedure (2/20, 10.0%).

Comparisons by Treatment Service

Overall, the orthopaedic surgery service managed 194 of the 299 cases (64.9%), including a larger relative proportion of bimalleolar- and trimalleolar-type injuries, whereas nearly two-thirds of patients treated by podiatry were unimalleolar injuries (Table 3, $P < 0.001$). Treatment by the podiatry service resulted in significantly more returns to the ED (Table 3, $P < 0.001$), higher readmission rates at 30 and 90 days (Table 5; $P = 0.005$), and more returns to the

TABLE 5. Adjusted Associations of Clinical Variables on Hospital Readmission and Total Postdischarge Cost Outcomes

	Readmission Within 30 Days		Readmission Within 90 Days		Total Postdischarge Costs	
	Adjusted OR (95% CI)	P*	90-Day Adjusted OR (95% CI)	P*	Adjusted Coefficient† (95% CI)	P*
Treatment service (podiatry)	2.37 (0.72–4.01)	**0.005**	1.70 (0.50–2.88)	**0.005**	1.72 (0.42–3.01)	**0.011**
Gender (male)	—	—	—	—	1.35 (0.03–2.68)	**0.046**
ASA category (high)	1.38 (0.19–2.58)	**0.024**	1.34 (0.242–2.44)	**0.017**	0.85 (−0.33 to 2.03)	0.152
BMI (kg/m^2)‡	0.01 (−0.06–0.08)	0.853	—	—	—	—
Length of stay (d)‡	0.17 (−0.03 to 0.37)	0.094	0.12 (−0.03 to 0.26)	0.116	—	—
Injury code (ref: group 1)						
2	−0.54 (−2.03 to 0.95)	0.479	−0.67 (−1.95 to 0.62)	0.309	0.10 (−1.38 to 1.58)	0.894
3	−0.10 (−1.86 to 1.65)	0.914	0.15 (−1.23 to 1.53)	0.831	0.18 (−1.67 to 2.02)	0.846
Diabetes	—	—	−0.262 (−1.64 to 1.13)	0.709	—	—
Race (ref: white)						0.114
Black	—	—	—	—	−0.65 (−2.04 to 0.75)	0.356
Other	—	—	—	—	−1.45 (−3.44 to 0.54)	0.148

Inclusion of clinical variables was based on provisional statistical significance with a *P*-value set at <0.20. Variables excluded from the table and blank regions in the multivariate analyses represent unmet criteria.
**P*-values for the adjusted calculations in the multivariate models are presented with bold values indicating statistical significance at the $P < 0.05$ level.
†Adjusted log-linear regression coefficients for the total postdischarge costs (continuous variable), reflecting each variable's relative effect on a single unit change.
‡Odds ratios for continuous variables represent increases in likelihood per unit change with a C-statistic of 0.804.
BMI, body mass index.

operating room to manage complications related to the primary procedure (Table 3, $P = 0.019$).

DISCUSSION

There is a paucity of literature with respect to cost analysis in the 90-day management of isolated ankle fractures.[12] To our knowledge, this is the first cost analysis study including the 90-day perioperative management period for isolated ankle fractures. Furthermore, given the well-established presence of a podiatry service at our institution, we were also able to demonstrate a detailed comparison between orthopaedics and podiatry as the primary treatment service for these injuries. Based on the results of our study, the podiatry service was a significant risk factor for increased use of postdischarge health care resources and overall post-discharge total costs, as demonstrated by greater than 2-fold risk for 30-day hospital readmission. Furthermore, treatment by podiatry conferred a 1.7-fold risk for hospital readmission at 90 days.

Institution-Based Treatment Service Trends

Since 2004, our institution has had an established podiatry service that has been able to claim an increasing share of the pool of patients for direct primary consultation from our hospital's ED, reaching 58% (41/71) of annual foot and ankle consultations by 2011.[13] Furthermore, although the study sample size reported in our current article seems relatively low, the same study from Jakoi's group found a total of only 19 operative ankle fractures during the 2007–2011 period. Nonetheless, our results at least suggest that the more complex (groups 2 and 3) ankle fracture patterns were managed by the orthopaedic service, whereas podiatry managed two-thirds of the unimalleolar ankle fractures. This also may at least partially explain why nearly one-half of podiatry-managed cases were performed in the outpatient setting (Table 3).

Inpatient Versus Outpatient Surgical Status

Several studies in orthopaedics have already reported significant cost savings without compromising the value of care and patient outcomes when shifting plausible orthopaedic procedures from the inpatient to the outpatient treatment setting. Ferrari et al[14] recently performed a meta-analysis of inpatient versus outpatient anterior cruciate ligament reconstruction and found cost savings up to $7390. In elective TJA, significant cost savings have been recognized for both total hip arthroplasty[15] and total knee arthroplasty[16] procedures. Similarly, Bettin et al[17] reported 30% reduction in total costs in the 90-day period in a retrospective review of operatively managed ankle fractures. Although the aforementioned study did not limit its investigation to isolated, closed injuries, the authors concluded that outpatient cases overall were about 30% cheaper than inpatient cases.[17] Our cost data similarly yield an approximate 36.2% difference between treatment settings (Table 4).

Hospital Readmissions

The URRs at our hospital were 5.4% (16/299) and 6.7% (20/299) at 30 and 90 days, respectively. The URRs observed across our entire cohort are slightly higher than previous a recent study by Basques et al,[10] reporting a 3.2% 30-day readmission rate in over 2500 ankle fracture patients identified in 2011 and 2012 via the American College of Surgeons National Surgical Quality Improvement Program database.[10] However, as demonstrated in Table 3, URRs for the orthopaedic subgroup of patients reached just 1.0% and 2.6% (2/299 and 5/299) at 30 and 90 days, respectively.

Understanding the readmission profile has important implications for developing future cost containment strategies. Approximately, two-thirds of hospital readmissions were infection-related and/or wound-related complications, and all returns to the operating room (9/9) were infection based and involved the primary surgical site. Previous literature has already tagged surgical site infections and subsequent management to be one of the costliest readmission diagnoses.[18,19]

Implications for the Potential Bundled Payment Initiatives

The goal of bundled payment models is to encourage physicians, hospitals, and all health care providers to provide more efficient, cost-effective care over the entire 90-day EOC. Although bundled payments in orthopaedics largely affect elective TJA, some hospitals already experience the triggered bundles for 90-day management of hip fractures.[20] Furthermore, orthopaedic cost containment and cost analysis literature is increasingly including cost reduction methods in isolated extremity injuries, such as distal radius fractures.[21]

Regional and geographical variations in patient populations and treatment practices highlight the importance of the critical assessment of various large, nationwide database-driven studies reporting certain risk factors as generalizable conclusions for all institutions. Varacallo et al[22] previously advocated a similar "institution-based" approach to applying these potential clinical risk factors in elective TJA hospital readmissions. In effect, this has the potential to provide each hospital with its own customized, high-yield clinical risk factor profile that can ultimately facilitate quality improvement strategies in potential future bundled payment models in health care.

Limitations

There are several key limitations in our study. First, our study lacks true randomization by treatment service introducing a selection bias of patients by primary treatment service group. Although Table 2 suggests similar patient demographics and clinical characteristics by treatment service, the selection bias mitigates the overall strength of our cost comparative conclusions. In addition, our data suggest that the more complex injuries were managed by the orthopaedic service.

Second, our results are institution based and lack generalizability. Although this could be considered as a strength when viewed from the institution's perspective in creating a customized high-yield clinical risk factor profile for 90-day EOC management of isolated operative ankle fractures, the patient population treated at our inner-city hospital consists of a disproportionate number of government-based insurance patients. This is certainly influenced by the proximity of several well-respected institutions in not only the city itself but in the nearby suburban communities.

Third, the surrounding institutional competition provides several potential "follow-up" destinations for ED presentations and hospital readmissions. In effect, our results potentially fall victim to underreporting the total postdischarge cost aggregates in addition to artificially low reported hospital readmission rates and incidence of postoperative complications. However, the risk of underreporting is expected to be similar in reference to our comparison between primary treatment services. Finally, we did not include patient outcomes data, and this was solely a retrospective analysis.

CONCLUSIONS

Ankle fractures are common and can be associated with significant health care costs, especially in the setting of postoperative complications and early unplanned hospital readmissions. It is important for individual institutions to understand the relevant clinical variables attributing to the 90-day EOC in the overall management of common, isolated orthopaedic trauma. Based on our findings, patients with an ASA score ≥3 and patients treated by the podiatry service as opposed to the orthopaedic service were at an increased risk of hospital readmission at both 30 and 90 days postdischarge. Furthermore, both the latter and male patients were independently associated with increasing total postdischarge costs in the 90-day EOC. Finally, outpatient cases were associated with two-thirds the total index hospital costs compared to inpatient cases. Given these findings, we suggest careful consideration be given to the primary treatment service in managing operative ankle fractures, and when indicated, these cases should be performed in the outpatient setting.

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