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RELATIONSHIP BETWEEN TIMING OF EMERGENCY PROCEDURES AND LIMB AMPUTATION IN PATIENTS WITH OPEN TIBIA FRACTURE: UNITED STATES, 2003 – 2009

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Abstract

Background—We aimed to characterize patterns in the timing of initial emergency procedures for patients with open tibia fracture and examine the relationship between initial procedure timing and in-hospital amputation.

Study Design—Data were analyzed from the Nationwide Inpatient Sample, 2003–2009. Adult patients were included if they had a primary diagnosis code of open tibia fracture. Patients were excluded for the following: transferred from or to another hospital, an immediate amputation was performed, more than one amputation was performed, no emergency procedure was documented, or treated at a facility that did not perform any amputations. We evaluated the association between timing of the first procedure and the outcome of amputation using multiple logistic regression, controlled for patient risk factors and hospital characteristics.

Results—Of 7,560 patients included in the analysis, 1.3% (n=99 patients) underwent amputation on hospital day 2 or later. The majority of patients (52.6%) underwent first operative procedure on day 0 or 1. In adjusted analyses, timing of first operative procedure beyond the day of admission is associated with more than three times greater odds of amputation (day 1 OR 3.81, 95% CI 1.80–8.07).

Conclusions—Delay of first operative procedure beyond the day of admission appears to be associated with a significantly increased probability of amputation in patients with open tibia fracture. All practitioners involved in the management of patients with open tibia fracture should seek a solution for any barrier, other than medical stability of the patient, of achieving early operative intervention.

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Keywords

amputation; debridement; emergent procedures; lower extremity reconstruction; lower extremity trauma; open tibial fracture

Advances in bone fixation techniques, vascular reconstruction, and soft tissue replacement make limb salvage possible for injuries that just three decades earlier were only amenable to amputation. Despite innovations in the treatment of severe lower extremity trauma, management of these injuries continues to be challenging and treatment decisions are a topic of debate for physicians and patients. Open fractures are at risk of developing severe complications and the most severe open tibia fractures often lead to amputation. Early operative debridement is considered one of the main factors in minimizing the risk of infection and improving the chance of limb salvage.

Nearly all studies reporting the impact of debridement timing on outcomes in open fracture treatment have evaluated outcomes of infection or nonunion (1–9). Despite the recommendation for emergency debridement in classic teaching and treatment protocols (10–12), the majority of the literature has been unable to show that delay of debridement beyond the six to eight hour window has adverse effects (2–5, 7–9, 13, 14). These findings may have been extrapolated by some providers to justify extending the time to first debridement beyond the day of initial injury. The impact of debridement delayed beyond 24 hours has not been addressed in the literature, and no studies have considered the outcome of amputation after open tibia fracture as a consequence of delayed initial treatment. There are few reports of practice patterns on a national level of timing of emergency procedures beyond what is reported at individual institutions, which are often tertiary care trauma centers (15, 16). Practice patterns in this population are particularly important because patients often receive multidisciplinary care, which may potentially help or hinder provision of prompt treatment.

A population-level analysis is necessary to understand whether providers are effectively treating patients with open tibia fracture on an emergent basis. The aim of this study is to characterize national patterns in the timing of the initial emergency procedures, including operative debridement, for patients with open tibia fracture and to examine whether there is a relationship between timing of the initial operation and the outcome of limb amputation. We hypothesize that performing emergency surgical intervention is not practiced at all centers on a national level, despite the recommendation for emergent treatment of open tibia fractures. In addition, we hypothesize that patients having delayed initial procedures will have an increased probability of amputation.

MATERIALS AND METHODS

Data Source

We performed a retrospective analysis of the Health Care Utilization Project Nationwide Inpatient Sample (NIS) administrative database from the years 2003 – 2009. The NIS is an annual stratified probability sample of approximately 20% of all U.S. non-federal (non-military) hospital admissions from the majority of states (44 states in 2009). The NIS is the largest allpayer inpatient care database, and each year contains approximately 8 million discharges from roughly 1,000 hospitals (17). The NIS has been utilized for many published analyses of national practice patterns and patient outcomes in the surgical literature (18–21). This study was given nonregulatory status by our Institutional Review Board.

Patient Selection

International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes were used to identify 18,383 patients with primary diagnosis of open tibia fracture (ICD-9-CM = 823.10, 823.12, 823.30, 823.32, 823.90 or 823.92). The goal was to identify a sample of adult patients admitted near the time of injury (i.e., not transferred from another facility) with acute primary injury of open tibia fracture in which immediate amputation was not performed. We made the assumption that it is rare to perform immediate amputation in patients who have a realistic chance of successful salvage. Thus, patients having immediate amputation on hospital day zero or one were excluded so that patients with the greatest likelihood of successful salvage are considered. In addition, we wanted to capture admissions at the facility that performed the definitive treatment and at facilities that perform amputations as a part of their practice. Patients were excluded from analysis in the following sequence (Figure 1): 8,451 patients treated at a facility that did not perform any amputations in the sample; 887 patients less than 18 years of age; 13 patients having more than one amputation; 408 patients transferred from another short-care hospital; 216 patients transferred to another short-care hospital; 50 patients discharged against medical advice; 439 patients not having any emergency procedure performed during admission; 114 patients with procedures performed before the admission on record (readmissions); and 145 patients having immediate amputation or timing of amputation unspecified. A total of 7,671 patients were identified for analysis.

Predictor and Outcome Variables

The NIS database contains ICD-9-CM procedure codes and timing of procedures, measured in calendar days. The outcome of interest was measured as amputation occurring at or below the knee and up to the ankle, which was identified by ICD-9-CM procedure codes outlined in Figure 2. Timing of the initial operative debridement, measured in days since admission, was noted. Because some patients likely have procedures coded other than debridement due to differences in reimbursement, even if debridement was in reality performed, additional emergency procedures were recorded as part of the overall initial operative treatment. Arterial repair, vein repair, nerve repair, placement of external fixator, open reduction and internal fixation, and amputation were also included as emergency procedures in addition to debridement. Timing of the initial emergency procedure was recorded for each patient as the predictor variable of interest. ICD-9-CM procedure codes were used to identify patients having these emergency procedures (Figure 2). Codes for debridement proximal to the knee and distal to the ankle were included in the analysis with the assumption that patients with acute open tibia fracture going to the operating room for debridement of any part of the lower extremity would have debridement of the open fracture as well. Patients having emergency procedures coded but timing unspecified were included in the analysis as a separate category. Patients having no emergency procedure coded were excluded from analysis as mentioned above, because there was no variation in outcome; none of these patients went on to have in-hospital amputation.

Control Variables

General categories of control variables identified were hospital characteristics, patient demographic data, economic characteristics, comorbidities, and injury characteristics (Figure 2). Hospital characteristics included trauma center status, urban/rural location, bed size, teaching status, and volume of open tibia fractures treated per year in quartiles. Patient demographic data included age, gender, and race. Economic characteristics included primary source of insurance and median household income for the patient’s zip code. Patient comorbidities included alcohol abuse, congestive heart failure, depression, diabetes with and without chronic complications, drug abuse, liver disease, hypertension with complications, peripheral vascular disease, and psychoses. Patients with congestive heart failure, hypertension with complications, and peripheral vascular disease were grouped into one category of cardiac comorbidities. Patients with diabetes and diabetes with chronic complications were grouped into one category of diabetic comorbidities. Injury characteristics included mechanism of injury, the presence of associated injuries, and an overall injury severity score. Using external cause of injury codes (Ecodes), we divided mechanism of injury into blunt, sharp/penetrating, and other/unspecified categories. Associated injuries and procedures included arterial injury (popliteal, anterior tibial, and posterior tibial), complicated open wound, tibial nerve injury, fasciotomy, or dislocation (knee and ankle), which were identified using ICD-9-CM diagnosis and procedure codes (Figure 2). An overall injury severity score was calculated for each observation using the ICDMAP-90 software (Tri-Analytics, Baltimore, MD) (22). The injury severity score (ISS) is commonly used to control for overall injury severity and predict mortality after trauma. The ICDMAP-90 was developed to generate injury severity scores, such as the ISS, from ICD-9-CM codes contained in administrative databases. The program is useful in situations when clinical information for standard calculation of severity scores is not available.

Missing Data

Missing data were accounted for by creating separate “missing” categories within the variable when more than 1% of data were missing. Race (21% missing), trauma center status (10% missing), mechanism of injury (7% missing), and income for patient zip code (4% missing) had separate categories for missing values in order to include these observations in the analysis. An additional 111 observations, 1.4% of the total sample meeting the inclusion criteria, were not included in the final analysis due to having a missing value in the group of control variables that by themselves each had <1% missing. The final sample included 7,560 patients with open tibial fracture.

Data Analysis

We evaluated the association between timing of the initial emergency procedure and the outcome of in-hospital amputation. Initially, bivariate comparisons between control variables and the outcome of amputation were performed. Bivariate logistic regression was used for the continuous variable of age. The remainder of variables were categorical, for which chi-squared test was used. Fisher’s exact test was used when frequencies for any categorical group were less than or equal to five patients. Control variables having significant (P value <0.05) bivariate associations with amputation were included in the final multiple logistic regression model, robustly adjusted for clustered sampling at the hospital level. Findings from the models were used to generate adjusted probabilities of amputation as the outcome. For all analyses, we treated the NIS data as a clinical sample of patients who met the inclusion criteria for this study and did not use statistical weights. The chief rationale for this approach is that we wished to examine patients treated only at hospitals that perform amputations, which is possible when the analysis is performed on unweighted data. Given this approach, our findings should be interpreted as those of a large clinical sample that is national in scope, rather than nationally representative. Statistical analyses were completed using STATA statistical software program (StataCorp LP, College Station, TX).

RESULTS

Characteristics of the Clinical Sample

Of 7,650 patients with open tibial fracture at 200 hospitals, 1.3% (n=99) underwent amputation on hospital day 2 or later (Table 1). The sociodemographic characteristics of patients in the sample are presented in Table 1, comparing patients who underwent amputation versus those who did not. Most patients were treated at teaching (84.3%), nontrauma centers (77.3%), in urban locations (98.3%) (Table 2). In addition, most patients had blunt mechanism of injury (81.5%) (Table 3). Associated arterial and tibial nerve injury were rare in the total sample (2.3% and 0.2% respectively). However, patients undergoing amputation had higher percentages of these associated injuries (Table 3).

Day of Initial Emergency Procedure and Limb Amputation

The majority of patients (52.6%) underwent initial emergency procedure on hospital day 0 or 1 (Table 4). Smaller proportions of patients underwent an initial procedure between hospital days 2 – 4 (10.5%) or beyond 4 days after admission (7.9%). Approximately thirty-percent of patients (29.0%) did not have timing of the emergency procedure documented. We found that the percent of patients undergoing amputation increases as the time to initial procedure increases (Figure 3). 0.5% of patients having emergency procedure on day 0 versus 6.3% of patients having initial procedure after day 4 had in-hospital amputation.

In analyses adjusted for patient and hospital characteristics and clinical risk factors, timing of the first operative procedure on hospital day 1 or later is associated with more than three times greater odds of amputation (day 1 odds ratio [OR] 3.81, 95% CI 1.80–8.07) compared to patients having initial procedures on hospital day 0 (Table 5). The odds of amputation continue to increase as timing of the initial operative procedure is delayed (day 2 OR 3.82, CI 1.51–9.64; day 3–4 OR 4.02, CI 1.83–8.83; day >4 OR 11.42, CI 5.93–21.99). Having timing of procedure unspecified was not associated with significantly increased odds of amputation (OR 0.61, CI 0.25–1.48). As anticipated, associated injuries of arterial and tibial nerve injury have increased odds of amputation. Meanwhile, urban hospitals have decreased odds of amputation. These findings help to validate our model and are concordant with what clinicians would anticipate from experience and prior studies. When accounting for control variables, including injury severity, the marginal probability of amputation increases from 0.6% if initial procedures are performed on day 0 to 2.0–2.1% if initial procedures are performed on day 1–4, increasing to 5.6% if the initial procedure is performed day 5 or later (Figure 4).

DISCUSSION

The findings of this national study over a 7-year period indicate that delay of the first operative procedure is associated with a significantly increased probability of amputation in patients with open tibial fracture. Based on our findings, patients who do not have immediate amputation and who are medically stable for surgery should undergo debridement on the day of admission to reduce the probability of amputation. Plastic surgeons should be involved in care immediately, rather than days after admission, to ensure proper steps have been taken to maximize successful outcome.

Despite the preference for limb salvage by patients and physicians (23, 24), some patients clearly benefit from amputation over reconstruction, and we have learned from prior studies that the average patient has similar functional outcome after amputation compared to limb salvage (25, 26). It is clear from clinical experience that not all amputations are avoidable, even for cases in which early intervention is performed. However, despite the widely accepted practice of emergency treatment of open fractures (10, 27), it appears that at least 30% of patients in our national sample had initial procedures performed on hospital day 1 or later. These results are similar to findings in a recent population study by Namdari et al. (16) that reported 24% of open tibial fracture patients in the National Trauma Data Bank experienced wait time to treatment greater than 24 hours. Patient injury severity may partially account for the delay in initial operative intervention. However, we controlled for overall injury severity score and limited our analysis to patients with primary diagnosis of open tibial fracture to minimize bias of associated traumatic injury on timing of procedures.

We hypothesize that hospital or physician culture, practice patterns, and resource limitations likely play a role in determining initial operative timing in these patients. For example, some patients may have bedside irrigation of open fractures performed in the emergency department with delay of additional operative procedures the following day when treating surgeons are available. Such practices may be associated with higher probability of amputation. Contributing factors leading to delay at the provider and facility levels merit further examination, and are beyond the scope of this study. However, a growing body of literature has reported poor adherence to practice guidelines when the passive dissemination of information is employed, such as publishing clinical practice guidelines or studies (28, 29).

This study has limitations inherent in the analysis of administrative data, such as the retrospective nature and absence of accompanying detailed clinical data. Unique to this database, there is lack of longitudinal continuity beyond the admission on record. Thus, we were unable to capture late amputations or other late complications such as osteomyelitis. Late amputations occurred in approximately 3% of patients in the attempted reconstruction group of the Lower Extremity Assessment Project (LEAP) study, the largest prospective longitudinal multicenter study to date (25). We would expect this proportion to be lower in our national sample because our sample included all open tibia fracture types, whereas the LEAP study included only severe open tibia fractures. In addition, the timing of the initial procedure was recorded in calendar days rather than hours. Despite this limitation, we are able to add to current knowledge surrounding delayed treatment in open fracture treatment, as the current literature does not address consequences of delay beyond 24 hours or the relationship between delay and limb amputation.

Another limitation is that we were constrained to using ICD-9-CM diagnosis and procedure codes to control for injury severity. As a consequence, we were unable to classify the open tibia fractures according to the commonly used Gustilo grading system (11). However, we were able to control for arterial injury, nerve injury, and presence of a complex wound based on available ICD-9-CM codes, which account for the most severe types of open tibia fractures. Unfortunately, we are unable to distinguish the precise severity of soft tissue injury with presence of the complex wound diagnosis. Lastly, we could not consider patient social and psychological factors, such as family support and self-efficacy, which may impact the decision to pursue reconstruction versus amputation. In the literature these factors have been shown to impact functional outcomes after either treatment (25, 26, 30). However, patient social and psychological factors have not been shown to impact the decision to perform amputation over limb salvage in the literature. Demonstration of the relationship between delay of treatment and increased probability of amputation can be strengthened in the future through separate analysis of another independent national data source or analysis of individual institution’s outcomes of open tibial fractures. However, review of data from institutions that do not treat large numbers of patients with open tibial fractures may not have sufficient power to fully evaluate the relationship.

Despite the limitations of this study, we were able to demonstrate a relationship between delay in initial operative intervention and an increased probability of amputation in patients with open tibia fracture. Hospitals and clinical departments treating these patients should examine practice patterns and limitations in being able to achieve early treatment. Medical stability is the only reason for delay that is in the best interest of the patient. All practitioners involved in managing these patients should seek a solution for any other barrier to achieving early operative intervention in order to prevent unnecessary amputation that may be attributed to delay in operative management. Changes in the process of care, such as immediate plastic surgery consultation and performing immediate operative intervention in medically stable patients, are unlikely to cause harm; rather these changes offer the potential to improve the likelihood of successful limb salvage.

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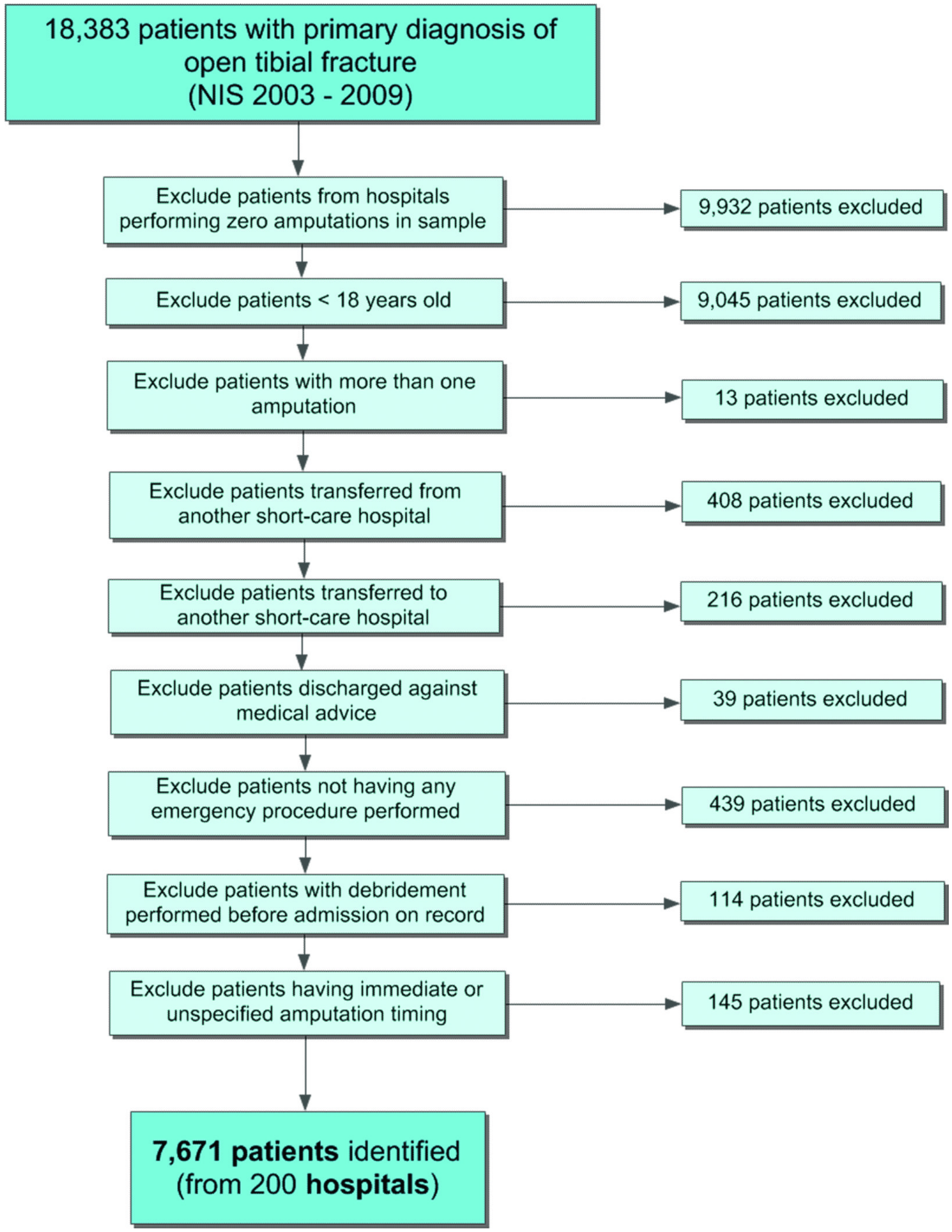

Figure 1.
Patient selection criteria.

Specifications of Study Variables	
Predictor Variable	
Operative debridement	ICD-9-CM procedure codes: 79.6, 79.60, 79.65, 79.66, 79.67, 79.68, 79.69, 77.6, 77.60, 77.65, 77.66, 77.67, 77.68, 77.69, 86.2, 86.22, or 86.28 (procedure timing supplied by NIS)
Additional emergency procedures (arterial/vein repair, nerve repair, placement external fixator, ORIF)	ICD-9-CM procedure codes: 39.30, 39.31, 39.32, 0.43, 0.45, 78.17, 78.57, or 79.36
Outcome Variable	
Amputation (at or below knee up to ankle)	ICD-9-CM procedure codes: 84.13, 84.14, 84.15, or 84.16 (procedure timing supplied by NIS)
Control Variables	
Trauma center status	Supplied directly by NIS
Hospital urban/rural location	Supplied directly by NIS
Hospital bed size	Supplied directly by NIS
Hospital teaching status	Supplied directly by NIS
Hospital volume open tibial fractures per year (in quartiles)	Determined by data supplied by NIS, using codes for open tibial fracture (ICD-9-CM diagnosis codes: 823.10, 823.12, 823.30, 823.32, 823.90 or 823.92)
Patient age	Supplied directly by NIS
Patient gender	Supplied directly by NIS
Patient race	Supplied directly by NIS
Patient primary insurer	Supplied directly by NIS
Median household income for patient's ZIP code (in quartiles)	Supplied directly by NIS
Patient comorbidities	Supplied directly by NIS (alcohol abuse, congestive heart failure, depression, diabetes with and without chronic complications, drug abuse, hypertension with complications, liver disease, peripheral vascular disease, and psychoses included in analyses)
Mechanism of injury	Clinical Classification System* (CCS) E-Codes supplied by NIS CCS E-Codes for blunt mechanism: 2603, 2606, 2607, 2608, 2609, 2610, or 2614) CCS E-Codes for sharp mechanism: 2601, 2605
Arterial injury (popliteal, anterior tibial, or posterior tibial)	ICD-9-CM diagnosis codes: 904.41, 904.51, or 904.53
Tibial nerve injury	ICD-9-CM diagnosis codes: 956.2
Complicated open wound	ICD-9-CM diagnosis codes: 891.1 or 891.2
Fasciotomy	ICD-9-CM procedure codes: 83.14
Dislocation (knee or ankle)	ICD-9-CM diagnosis codes: 836.51, 836.52, 836.53, 836.54, 836.61, 836.62, 836.63, 836.64, 837.0, or 837.1
Overall injury severity score (ISS)	Supplied by ICDMAP-90 software

*CCS software accompanies NIS database to allow external cause of injury (E-Codes) to be grouped into limited categories

Figure 2.

Specifications of study variables. *CCS software accompanies NIS database to allow external cause of injury (E-Codes) to be grouped into limited categories.

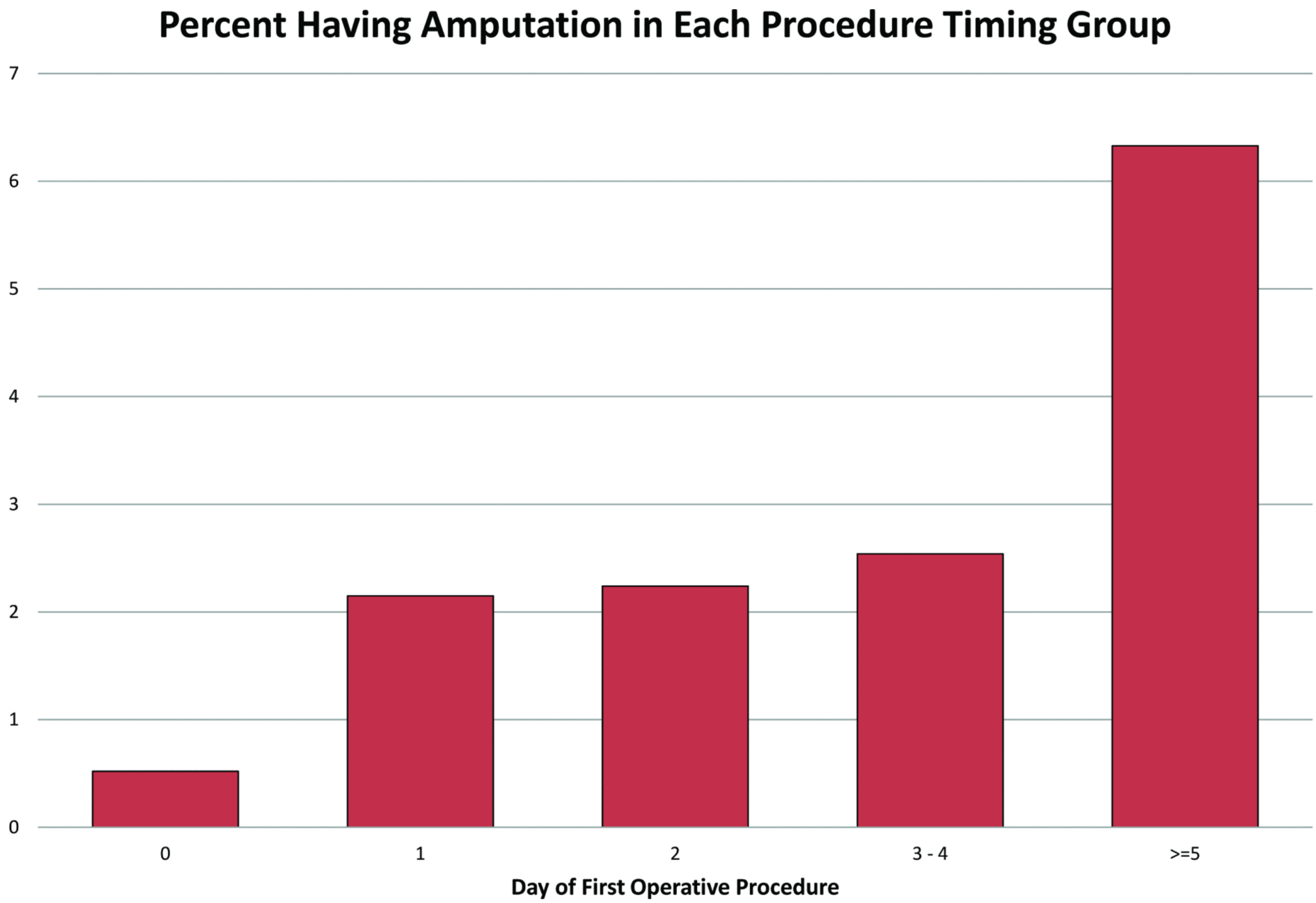

Figure 3.
Percentage of patients having amputation in each emergency procedure timing group.

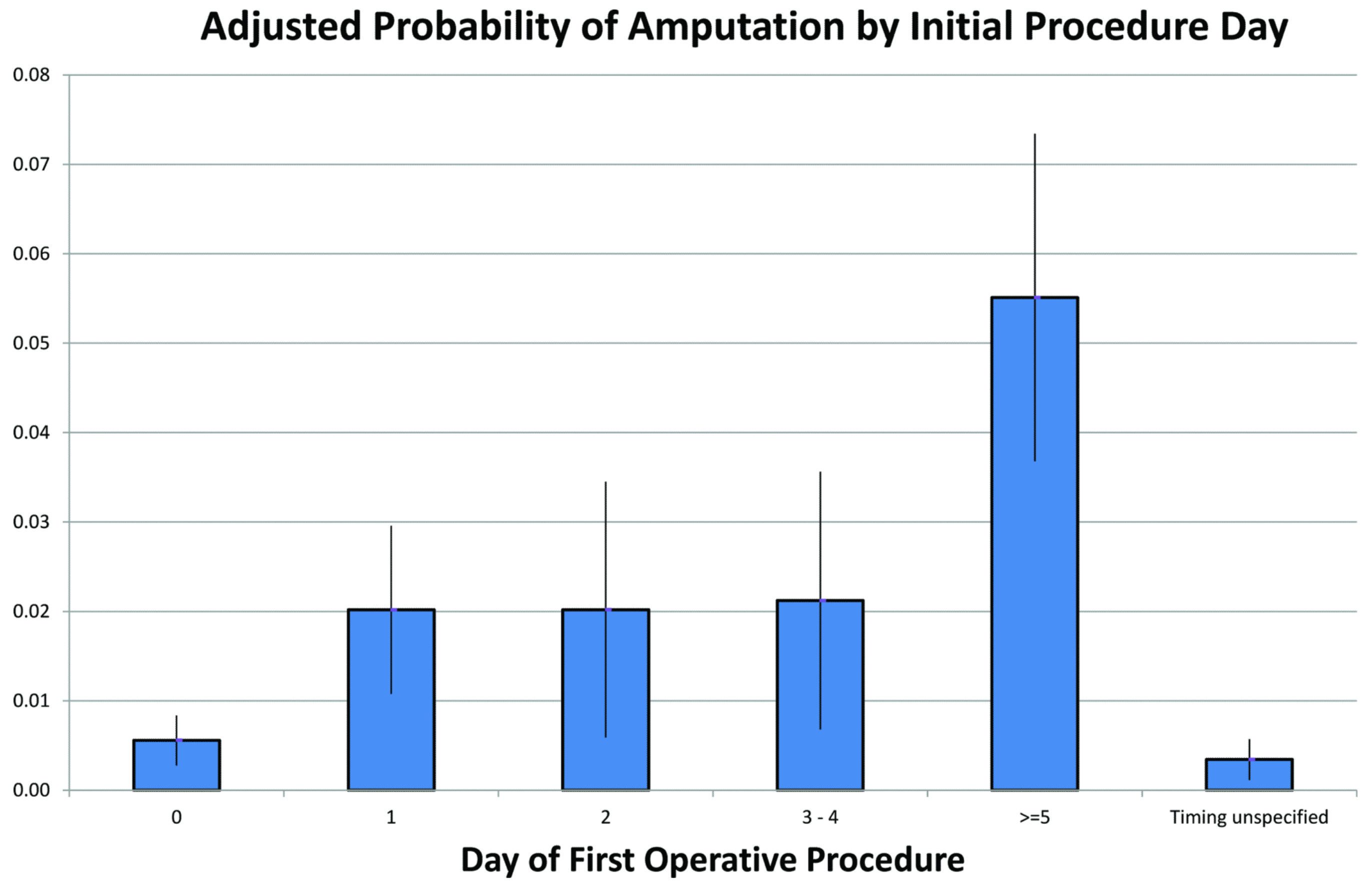

Figure 4.
Adjusted marginal probability of amputation in each emergency procedure timing group (vertical lines represent 95% confidence interval of estimates).

Table 1

Demographic and Economic Characteristics of Patients with Open Tibial Fracture

	Amputation		Salvage		All Patients	
	n	**%**	**n**	**%**	**n**	**%**
	99	**1.3**	**7,461**	**98.7**	**7,560**	**100**
Demographics						
Age						
Mean, SD	46.0	16.3	40.3	15.7	40.4	15.7
Gender						
Male	84	84.9	5,610	75.2	5,694	75.3
Female	15	15.2	1,851	24.8	1,866	24.7
Race						
White	61	61.6	3,696	49.5	3,757	49.7
Black	11	11.1	1,014	13.6	1,025	13.6
Hispanic	11	11.1	917	12.3	928	12.3
Other	4	4.0	292	3.9	296	3.9
Unspecified	12	12.1	1,542	20.7	1,554	20.6
Economic Characteristics						
Median household income for ZIP						
1st quartile	25	25.3	2,495	33.4	2,520	33.3
2nd quartile	32	32.3	1,826	24.5	1,858	24.6
3rd quartile	29	29.3	1,711	22.9	1,740	23.0

	Amputation		Salvage		All Patients	
	n	**%**	**n**	**%**	**n**	**%**
	99	**1.3**	**7,461**	**98.7**	**7,560**	**100**
4th quartile	10	10.1	1,148	15.4	1,158	15.3
Unspecified	3	3.0	281	3.8	284	3.8
Insurance						
Uninsured	22	22.2	2,578	34.6	2,600	34.4
Medicare	15	15.2	543	7.3	558	7.4
Medicaid	16	16.2	850	11.4	866	11.5
Private insurance	46	46.5	3,490	46.8	3,536	46.8

Table 2

Hospital Characteristics of Patients Treated with Open Tibial Fracture

	Amputation		Salvage		All Patients	
	n	**%**	**n**	**%**	**n**	**%**
	99	**1.3**	**7,461**	**98.7**	**7,560**	**100**
Admission type						
Trauma center	20	20.2	971	13.0	991	13.1
Nontrauma center	69	69.7	5,774	77.4	5,843	77.3
Unspecified	10	10.1	716	9.6	726	9.6
Location						
Urban	94	95.0	7,338	98.4	7,432	98.3
Rural	5	5.0	123	1.7	128	1.7
Bed size						
Small	2	2.0	81	1.1	83	1.1
Medium	29	29.3	1,441	19.3	1,470	19.4
Large	68	68.7	5,939	79.6	6,007	79.5
Teaching status						
Nonteaching	11	11.1	1,176	15.8	1,187	15.7
Teaching	88	88.9	6,285	84.2	6,373	84.3
# cases open tibial fracture per year by hospital						
1st quartile (<=21 cases/yr.)	30	30.3	1,996	26.8	2,026	26.8
2nd quartile (21 – 35 cases/yr.)	22	22.2	1,876	25.1	1,989	25.1

	Amputation		Salvage		All Patients	
	n	**%**	**n**	**%**	**n**	**%**
	99	**1.3**	**7,461**	**98.7**	**7,560**	**100**
3rd quartile (36 – 57 cases/yr.)	18	18.2	1,805	24.2	1,823	24.1
4th quartile (>57 cases/yr.)	29	29.3	1,784	23.9	1,813	24.0

Table 3

Cmorbidities and Injury Characteristics of Patients with Open Tibial Fracture

	Amputation		Salvage		All Patients	
	n	%	n	%	n	%
	99	**1.3**	**7,461**	**98.7**	**7,560**	**100**
Comorbidities						
Alcohol abuse	11	11.5	974	13.2	985	13.2
Cardiac (CHF, PVD, HTN w/ complications)	30	30.3	1,213	16.3	1,243	16.4
Depression	7	7.3	271	3.7	278	3.7
Diabetes	16	16.2	406	5.4	422	5.6
Drug abuse	7	7.3	494	6.7	501	6.7
Liver disease	2	2.1	88	1.2	90	1.2
Psychoses	4	4.1	197	2.7	210	2.7
Associated injuries/procedures						
Arterial injury (popliteal, AT, PT)	16	16.2	157	2.1	173	2.3
Complicated open wound	9	9.1	345	4.6	354	4.7
Tibial nerve injury	3	3.0	8	0.1	11	0.2
Fasciotomy	12	12.1	396	5.3	408	5.4
Dislocation	1	1.0	42	0.6	43	0.6
Injury severity score (ISS)						
<10	62	62.6	4,806	64.4	4,868	64.4
10–20	30	30.3	2,056	27.6	2,086	27.6

	Amputation		Salvage		All Patients	
	n	**%**	**n**	**%**	**n**	**%**
	99	**1.3**	**7,461**	**98.7**	**7,560**	**100**
>20	7	7.1	599	8.0	606	8.0
Mechanism of injury						
Blunt	83	83.8	6,078	81.5	6,161	81.5
Sharp/penetrating	4	4.0	529	7.1	533	7.1
Other	5	5.1	327	4.4	332	4.4
Unspecified	7	7.1	527	7.1	534	7.1

Table 4

Timing of First Emergency Procedure in Patients with Open Tibial Fracture

	Amputation		Salvage		All Patients	
	n	**%**	**n**	**%**	**n**	**%**
	99	**1.3**	**7,461**	**98.7**	**7,560**	**100**
Days to first emergency procedure						
HD #0	16	16.16	3077	41.2	3093	40.91
HD #1	19	19.19	863	11.6	882	11.67
HD #2	9	9.09	392	5.3	401	5.3
HD #3–4	10	10.1	384	5.2	394	5.21
HD #5 or greater	38	38.38	562	7.5	600	7.94
Timing unspecified	7	7.07	2183	29.3	2190	28.97

Table 5

Adjusted Multiple Logistic Regression Results

	Multiple Logistic Regression*		
	n = 7,560		
	OR**	95% CI	P
Demographics			
Age (unit = 10 years)	1.177	0.998–1.388	0.054
Gender			
Male	Reference group		
Female	0.407	0.244–0.680	0.001
Economic Characteristics			
Insurance			
Uninsured	0.681	0.413–1.123	0.132
Medicare	1.571	0.823–2.997	0.171
Medicaid	1.477	0.778–2.804	0.233
Private insurance	Reference group		
Treatment Characteristics			
Days to first emergency procedure			
HD #0	Reference group		
HD #1	3.814	1.801–8.074	<0.001
HD #2	3.816	1.511–9.638	0.005
HD #3–4	4.023	1.832–8.832	0.001
HD #5 or greater	11.417	5.928–21.991	<0.001
Timing unspecified	0.611	0.251–1.484	0.276
Patient/Injury Characteristics			
Injury severity score (ISS)			
<10	Reference group		
10 – 20	1.067	0.712–1.600	0.754
>20	0.714	0.318–1.602	0.414

	Multiple Logistic Regression*		
	n = 7,560		
	OR**	95% CI	P
Comorbidities			
Diabetes	2.599	1.115–6.058	0.027
Cardiac (CHF, PVD, HTN w/ complications)	1.106	0.548–2.234	0.778
Associated injuries/procedures			
Arterial injury (popliteal, AT, PT)	7.279	3.446–15.376	<0.001
Tibial nerve injury	15.669	1.950–125.927	0.010
Complicated open wound	1.664	0.928–2.984	0.087
Fasciotomy	1.111	0.434–2.842	0.827
Hospital Characteristics			
Admission type			
Trauma center	1.390	0.872–2.215	0.167
Nontrauma center	Reference group		
Unspecified	1.049	0.559–1.971	0.881
Location			
Rural	Reference group		
Urban	0.280	0.137–0.570	<0.001
Bed size			
Small	2.655	0.590–11.942	0.203
Medium	1.844	1.098–3.095	0.021
Large	Reference group		

*grey boxes indicate nonsignificant odds ratio

**All odds ratios (OR) adjusted for patient demographic, economic, injury risk factors, and hospital control variables that appear in Figure 2.