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Technical Report
Office of Vehicle Safety Research

CIREN Report

Consequences and Costs of Lower-Extremity Injuries

CRASHES

INJURIES

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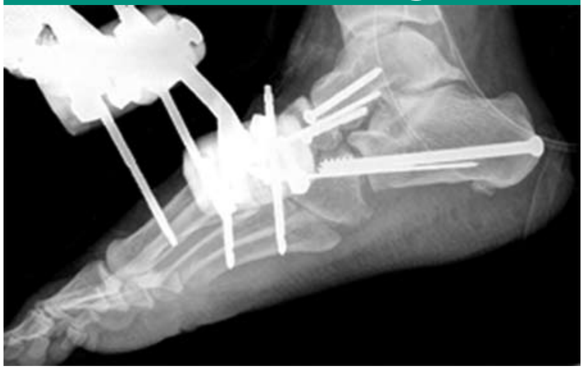

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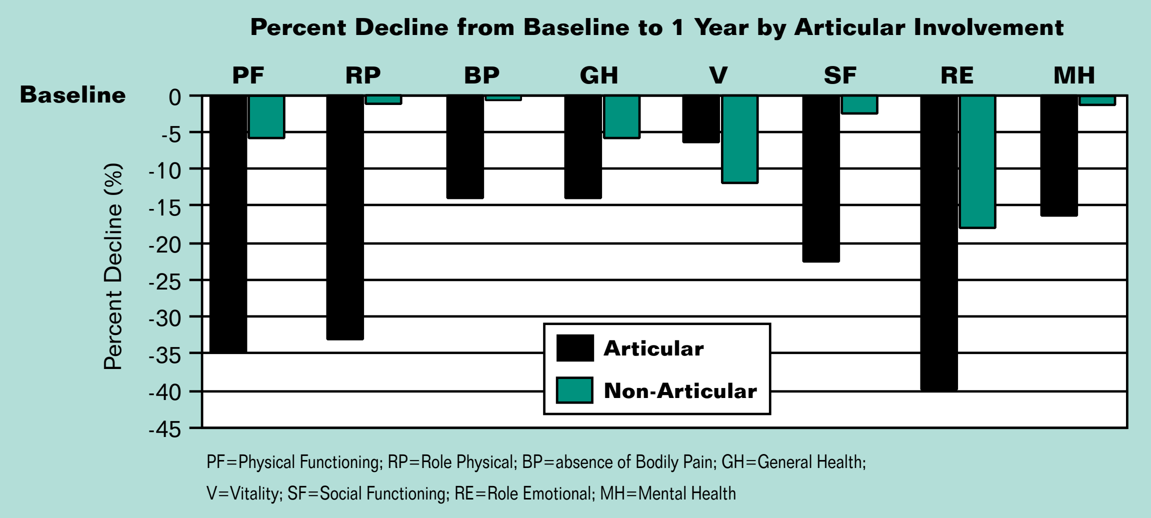

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16. Abstract

This report by NHTSA Crash Injury Research and Engineering Network (CIREN) researchers provides details on many typical lower-extremity injuries occurring in crashes and documents the resulting long-term consequences and costs.

With increasing use of safety belts and the introduction of air bags within the last 10 years, there has been a relative increase in the significance of lower-extremity injuries (LEI) in motor vehicle crashes. More occupants are surviving high-energy crashes due to the lower incidence and severity of head, thoracic, and abdominal injuries. Now many survivors are left with disabling lower-extremity injuries. Thus, lower-extremity injuries now are receiving greater attention. Among patients admitted to trauma centers following motor vehicle crashes, approximately 20 percent of drivers had at least one lower-extremity fracture.

Lower-extremity injuries from car crashes often involve articulating weight-bearing joints of the hip, knee, ankle, and foot. Fractures that involve weight-bearing surfaces frequently result in prolonged reductions in mobility and long-term impairment and disability. The disabling nature of these injuries currently is not properly reflected in their low scores on the most commonly used injury severity scales based on threat-to-life.

The long-term impact of LEI injuries, including the physical, psychosocial, and financial burden, cannot be determined at the time of hospital discharge, when outcome determinations are often made in most data collection systems. Many LEI require multiple surgeries, subsequent to initial hospital discharge, as well as rehabilitation. The long-term consequences and costs of LEI frequently deplete family finances and result in a myriad of psychosocial problems that impede return to pre-injury functioning. Many patients still exhibit problems related to their LEI at one year post-injury.

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Consequences and Costs of Lower-Extremity Injuries

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Introduction

With increasing use of safety belts and the introduction of air bags within the last 10 years, more occupants are surviving high-energy crashes that previously resulted in severe head, thoracic and abdominal injuries. Many of these survivors now must deal with disabling lower extremity injuries (LEI). Thus lower extremity injuries have become relatively more significant and are receiving greater attention.

Among patients admitted to trauma centers following motor vehicle crashes, approximately 20 percent of drivers had at least one lower-extremity fracture. The highest incidence rate for an LEI fracture is 5.7 percent for ankle injuries [1]. Surveys also suggest that foot and ankle injuries account for 8-12 percent of all moderate-to-serious injuries sustained by motor vehicle occupants involved in frontal collisions [2-4]. In a study of the one-year treatment charges for persons hospitalized in Maryland with vehicle-related injuries, persons with lower extremity injuries accounted for 40 percent of the hospital charges [5].

Lower-extremity injuries from car crashes tend to be high-energy injuries. These injuries have a poorer prognosis than comparable low-energy injuries caused by slips and falls [6]. Because they involve weight-bearing surfaces and major articulating joints, hip, knee, ankle, and foot fractures often result in prolonged reductions in mobility. LEI fractures often involve the complex weight-bearing joints of the ankle and foot that result in long-term impairment and disability. The disabling nature of these injuries currently is not properly reflected in their low scores on injury severity scales. This is because the Abbreviated Injury Scale (AIS) [7] is primarily designed to estimate threat-to-life, not to characterize the disabilities associated with nonfatal outcomes.

The long-term impact of these injuries, including the physical, psychosocial, and financial burden, cannot be determined at the time of hospital discharge, when outcome determinations are often made in most data collection systems. Many LEIs require multiple surgeries, subsequent to initial hospital discharge, as well as rehabilitation. The long-term consequences and costs of LEI frequently deplete family finances and result in a myriad of psychosocial problems that impede return to pre-injury functioning. Many patients still exhibit problems related to their LEI at one year post-injury [8-11]. Thus, the purpose of this report is to document long-term consequences and costs associated with lower extremity injuries. Special focus is given to injuries to joints of the ankle and foot that, despite their low AIS scores, can result in long-lasting disability and decreased quality of life.

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In a long-term study of patients admitted to trauma centers, it was noted that, among individuals with moderate or severe injuries to the extremities, only 58 percent had returned to work one year after injury [9]. Another study of functional outcomes (perceived limitations in performing everyday activities) after lower-extremity fracture revealed that a significant proportion of patients hospitalized for treatment of a unilateral, or one-limb, fracture of the lower extremity remained physically impaired at 6 months after discharge from the hospital. The ankle joint was most often affected, with 55 percent of the patients showing evidence of abnormal dorsi/plantar flexion [10]. At 12 months after hospital discharge, half of the patients still reported minor to moderate disabilities. Six- to 12-month improvements were noted for patients with both single and multiple metaphysial or shaft fractures in one limb. Patients with foot fractures, however, showed no improvement. Measures of patient-oriented outcomes were worse for persons with three or more fractures to the same extremity and for fracture patterns typical of high-energy crashes [12].

In another follow-up study of trauma patients conducted in the Netherlands, patients with ankle fractures were chosen as a control group with "lesser injuries" to be compared to patients with more serious injuries. Thus, investigators were surprised to learn that, at 6 years post-injury, the differences between the two groups were not as pronounced as they had presumed. That is, those with ankle fractures reported considerable physical and psychological problems attributable to their injury. There were no major differences between the proportions of the two groups who were able to return to work, and the percentage of those who had to change their occupation or who received disability benefits due to the consequences of the injury did not differ much between the two groups [13].

While the devastating impact of lower-extremity injuries is not new to orthopaedic surgeons, the disabling nature of some specific types of LEI is generally not well recognized. The most commonly used injury scoring systems are ICD-9 (International Classification of Diseases, 9th revision) [14] and AIS. ICD-9 is an international categorization of disease and injury whereas AIS was developed specifically for motor vehicle related injuries and ranks those injuries by severity, primarily by estimated threat to life. However, these injury-severity coding systems do not provide appropriate detail with respect to the most disabling LEI injuries, that is, those that involve an articular surface, such as tibial plateau or ankle fractures. While ICD-9 and AIS codes do indicate the presence of a tibial fracture, no indication is given that the articular surface, where two bones meet to form a joint, has been disrupted. Such a description requires more definitive clinical input, which is usually not available from large population-based datasets such as the National Highway Traffic Safety Administration's (NHTSA) National Automotive Sampling System (NASS) data or data derived from hospital discharge records. In addition, without considering the long-term outcomes of specific LEIs, the overall impact in terms of physical and psychosocial functioning cannot be ascertained.

Data from NASS reveal that lower extremities (at or below the pelvis) are the most frequent AIS 2+ injured body region for front outboard occupants in air bag-equipped vehicles. Injuries to the ankle/foot complex accounted for 33 percent of these LEI, and for 41 percent of the life-years lost to injury [15].

From the perspective of the Crash Outcome Data Evaluation System (CODES) and the Crash Injury Research and Engineering Network (CIREN), both NHTSA-sponsored projects, it is possible to study the mechanism and patterns of injuries, as well as the injury outcomes. The CODES and CIREN databases provide important complementary information. CODES, which is a population-based study, provides the "big picture" of the prevalence of injury among those involved in motor vehicle crashes (including those who sustain minor, moderate, and severe injury), while CIREN enables an in-depth look at the mechanism of a particular injury, and provides significantly greater injury detail, based on clinical observations of crash victims admitted to trauma centers (i.e., primarily those who sustain serious and/or disabling injury).

In this report, initial analyses (Part I) are based on the overall epidemiologic characterization of lower extremity injuries provided by Maryland CODES. These analyses are then repeated (Part II), using CIREN data, in order to compare the population-based findings from Maryland CODES with the more selective trauma center cases included in CIREN. Further analyses of CIREN data then focus on the mechanism and long-term outcomes of these LEI injuries.

In Part III, detailed analyses of follow-up data from the Maryland CIREN Center are presented, based on 6- and 12-month post-injury interviews for a subset of patients with lower-extremity injuries. In this part of the report, the comprehensive follow-up data documents human consequences of LEI to individuals and families, including psychological, social and financial burdens of LEI trauma. Also, more specific details on outcomes and costs are provided for a subset of 10 cases with isolated LEI (i.e., only one LEI and no other injuries) in an attempt to estimate the consequences and costs attributable to specific fracture types.

I. Population-Based Data On Motor-Vehicle-Related Lower-Extremity Injuries

(Maryland CODES)

Methods

For this report, we have conducted an in-depth analysis of the available costs attributable to lower extremity injuries. As part of the CODES project, hospital discharge records for the entire State of Maryland were obtained to examine the costs of LEI injuries. People who sustain an injury in a motor vehicle crash can be identified by E-codes (i.e., mechanism of injury), which were available for 90 percent of injured patients. This allowed for a comprehensive examination of statewide costs of initial hospital charges for LEI injuries due to motor vehicle crashes. We analyzed calendar year 2000 and 2001 data from Maryland's CODES project, in an effort to identify all occupants injured in motor vehicle crashes in Maryland, and treated in Maryland hospitals. These cases were classified into groups as displayed in table 1.

Table 1 - Stratification of Lower Extremity Injuries

Injury Group	Description
No lower-extremity injury	No injury involving the lower extremities
Single lower-extremity injury	**Single (one bone or dislocation)** injury to **one** lower extremity with MAIS $\geq$ 2, all other body regions with MAIS $\leq$ 1
Multiple lower extremity	**Two or more** total injuries in one or both lower extremities with MAIS $\geq$ 2, all other body regions with MAIS $\leq$ 1
Lower extremity and other injuries	At least one lower-extremity injury with MAIS $\geq$ 2, plus MAIS $\geq$ 2 in at least one other body region

* MAIS= Maximum AIS score

The definitions for these groups will be universal for other data presented in the remainder of this report.

Lower-extremity injuries corresponding to the pelvis and below were defined by the following ICD-9 codes in CODES: 820-825.39, 808, 835.0, 836, 837, 838.1. These codes were translated into AIS scores for Maximum Abbreviated Injury Scale (MAIS) calculation using ICD-9 Map software for this project [16].

Due to the large number of cases in the CODES dataset, it was also possible to determine the initial in-hospital charges for specific fracture types. However, since the hospital discharge data contain only ICD-9 codes, it was not possible to group diagnoses by the more detailed Orthopaedic Trauma Association (OTA) codes [17], which are available in CIREN data. It also was not possible to obtain an estimate of costs sustained after the patient was discharged from the hospital following the initial stay, since CODES is based on initial hospital discharge data. Because mean values may be influenced by a few extreme cases, median (i.e., the 50th percentile) hospital charges are presented.

Results

Table 2 contains CODES data for all Maryland drivers and passengers hospitalized with injuries during calendar years 2000 and 2001. There were a total of 9,927 drivers and passengers hospitalized during this period. Of that group, the vast majority (78.7 percent) sustained no lower-extremity injuries, while 7.4 percent incurred only a single LEI, 2.5 percent had multiple LEIs, and 11.4 percent had an LEI and at least one other significant injury. Thus, among those with an LEI, 34.8 percent suffered a single LEI, 11.7 percent had multiple LEI, and 53.5 percent had an LEI and an injury to at least one other body region.

Table 2 - Motor Vehicle Drivers and Passengers, Urgent or Emergent Admission

MD CODES Data, 2000-2001 (N=9,927)

Lower-Extremity Injury	Frequency	Percent	% Total LEI
No lower-extremity injury	7,809	78.7	
Single lower-extremity injury	737	7.4	34.8
Multiple lower extremity	248	2.5	11.7
Lower extremity and other injuries	1,133	11.4	53.5
Total	**9,927**	**100.0**	

Displayed in table 3 are median values of age, Injury Severity Score (ISS), length of hospital stay (LOS), and hospital charges for the patients stratified in table 1. There is little difference in age across the four groups. The fourth group (LEI and other injury) has, as expected, a much higher ISS score than the other three groups, since the square of the AIS score from one to three body regions is used in the calculation of ISS. Only injuries to the lower extremities figure into the ISS calculation for the single and multiple LEI groups.

Total In-hospital charges for drivers and passengers in Maryland for 2000 were $49 million, of which approximately $21 million (43 percent) were attributable to patients with LEI. Hospital charges for the State increased to $56 million in 2001, of which approximately $25 million (45 percent) were attributable to patients with LEI. A comparison of hospital charges among diagnostic groups in both CODES and CIREN appears later in this report.

Table 3 - Patient and Injury Characteristics by LEI Grouping
MD CODES Data, Calendar Years 2000-2001 (N=9,927)

Median	No LEI	Single LEI	Multiple LEI	LEI and other injury
N	7,809	737	248	1,133
Age (years)	34	33	34	35
ISS	4	5	7.5	14
LOS (days)	1	3	5	6
In-Hospital Charges $	$3,301	$8,546	$14,812	$17,180
Total $ in 2000 (Million)	$27.9	$4.2	$2.6	$14.6
Total $ in 2001 (Million)	$31.1	$4.7	$2.8	$17.8

As shown in table 4, median initial in-hospital charges were much higher for the treatment of fractures sustained above the knee, such as a long-bone fracture (e.g., femoral shaft, $12,623), when compared to injuries occurring to the smaller bones of the foot or ankle (e.g., talus, $7,848). One of the primary reasons for this difference is the higher cost of the orthopaedic hardware required for fixation of the long bones. However, it is important to note that this table *only addresses the in-hospital charges*, i.e., those charges incurred as part of the initial hospitalization following injury. Subsequent charges, including those for rehabilitation therapy, are not available from hospital discharge data, which forms the basis of CODES. Figure 1 illustrates the nature of several of the fractures identified in table 4.

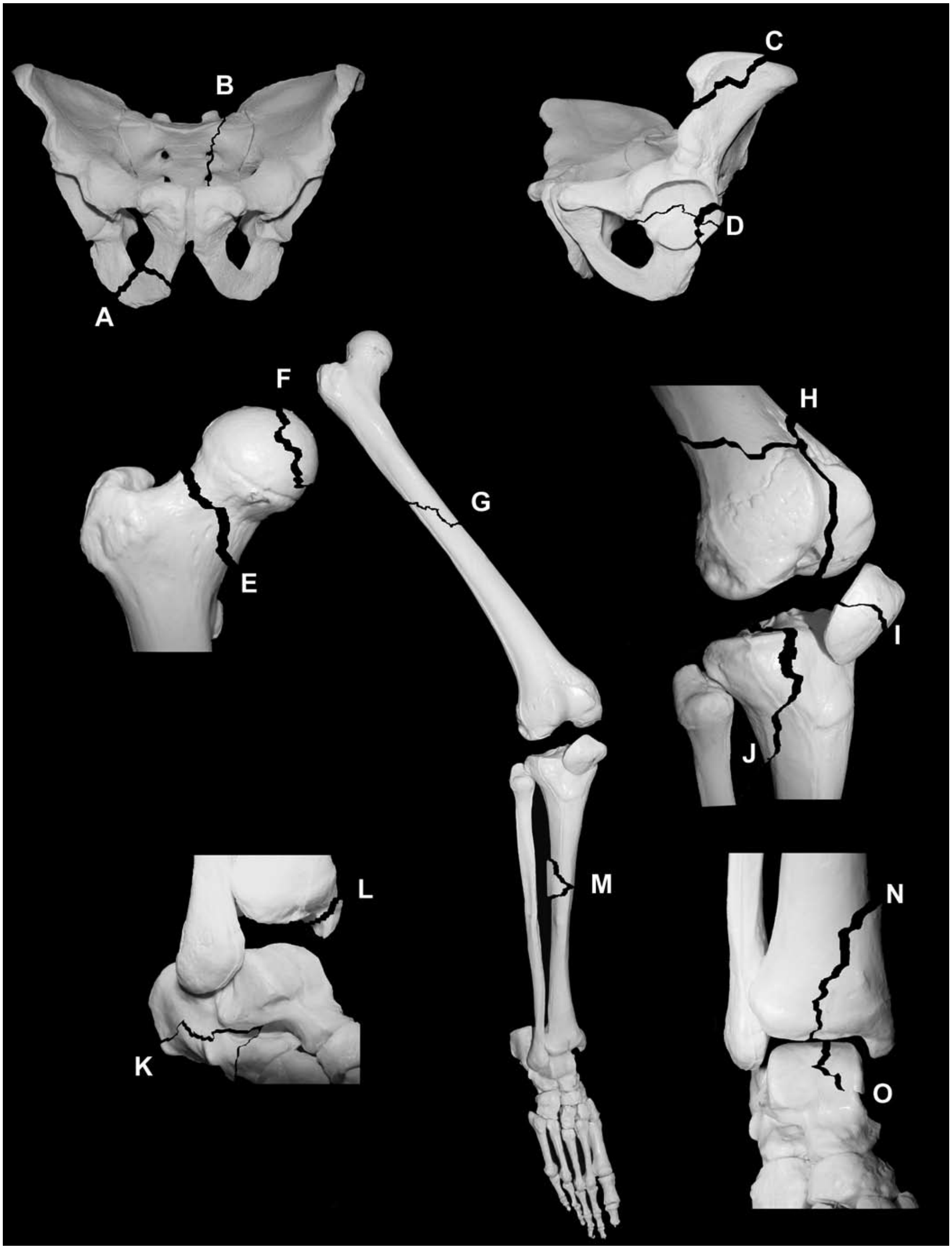
Table 4 - Median In-Hospital Charges for Single Lower-Extremity Injuries*
MD CODES Data, 2000-2001 (N=737)

Body Region	Injury	N	Median
Pelvis (D)	Acetabulum Fracture	68	$20,723
(A)	Sacroilium/Pubic Symphysis Fracture	54	$4,486
(A – D)	Open/closed Pelvic Fracture	142	$6,662
Upper leg (F)	Femur Head Fracture	60	$14,712
(G)	Femur Shaft Fracture	145	$12,623
Knee (I)	Patella Fracture	47	$5,157
Lower Leg (M)	Tibia Shaft Fracture	122	$9,093
Ankle	Bimalleolar or Trimalleolar Fracture	57	$7,541
(L)	Medial Malleolus Fracture	17	$5,347
(N)	Ankle Fracture	130	$6,220
	Ankle Dislocation	5	$6,561
Foot (K)	Calcaneus Fracture	20	$4,956
(O)	Talus Fracture	14	$7,848
	Metatarsal or Tarsal Fracture	64	$5,025

*Body Region Fractures are related to Simplified Graphics in figure 1 by the Letters A through O.

Note: Injuries are listed by descending body region, and charges are only for initial hospital stay.

Figure 1 - Simplified Graphic Representations of LEI Fractures



A	Pubic Rami Fx	**C**	Iliac Wing Fx	**E**	Femoral Neck Fx	**G**	Femoral Shaft Fx	**I**	Articular Patella Fx	**K**	Articular Calcaneus Fx	**M**	Tibial Shaft Fx	**O**	Articular Talus Fx
B	Sacral Fx	**D**	Articular Acetabulum Fx	**F**	Articular Femoral Head Fx	**H**	Articular Distal Femur Fx	**J**	Articular Proximal Tibia Fx	**L**	Articular Medial Malleolar Fx	**N**	Articular Distal Tibia “Pilon” Fx		

II. In-Depth Trauma-Center-Based Crash Reconstruction Data (CIREN)

Methods

A similar analysis was conducted using the central CIREN database. While it is not population-based, CIREN provides much more clinical detail than does CODES as data are prospectively obtained and there is ongoing collaboration of multidisciplinary team members composed of physicians, engineers, crash investigators, and others. Based on input from trauma clinicians, it is possible to use more specific coding schemes such as the AIS score and the coding system of the Orthopaedic Trauma Association (OTA) [17]. This system allows for finer classification of the nature and severity of lower-extremity fractures. OTA coding requires clinical review of appropriate radiographic studies for each fracture and/or dislocation and describes their exact location and complexity. In conjunction with data on long-term outcomes provided from patient interview, this coding system greatly improves the abilities to document the burden of lower-extremity injuries, and the patient's return to pre-injury functional status. In fact, the Association for the Advancement of Automotive Medicine (AAAM) is currently developing an updated AIS coding system (AIS 04) that incorporates detail on articular fracture patterns. This new system will assign more specific severity codes based on extent of disability as well as threat to life.

Lower-extremity injury in the CIREN project is defined as skeletal injuries involving joints or bones at and below the pelvis. These injuries correspond to AIS codes with the first two digits equal to '85' and a severity of 2 or higher. Each AIS code is counted as one injury; two injuries are counted for those cases with two codes that are exactly the same. The stratification of lower-extremity injury remains as previously described in table 1.

Results

As of August 2003, there were 1,750 cases in CIREN. Of these, 987 (56.4 percent) involved at least one lower-extremity injury. The CIREN cases were stratified according to injury group in table 5. Less than half (43.6 percent) sustained no lower extremity injuries, while 5.0 percent incurred only a single LEI, 7.7 percent had multiple LEIs, and 43.7 percent had a LEI and at least one other significant injury in a separate body region. Among those with LEI, 9.0 percent suffered a single LEI, 13.7 percent had multiple LEI, and 77.3 percent had an LEI and an injury to at least one other body region. The differences in percentages between table 5 and table 2 reflect the fact that CIREN includes trauma patients involved in a motor vehicle crash, whereas CODES includes all drivers and passengers hospitalized in Maryland, many of whom sustained injuries of a lesser severity.

Table 5 - Motor Vehicle Driver or Passenger, Urgent or Emergent Admission
All CIREN Centers (N=1,750)

Injury Group	Frequency	Percent	% Total LEI
No lower-extremity injury	763	43.6	
Single lower-extremity injury	88	5.0	9.0
Multiple lower extremity	134	7.7	13.7
Lower extremity and other injuries	765	43.7	77.3
Total	**1,750**	**100.0**	

A total of 2,472 lower-extremity injuries, based on AIS codes, were associated with the 1,750 CIREN cases (table 6a). Sixty-five percent of these injuries occurred above the ankle and another 22 percent involved the ankle or foot; the remaining 13 percent involved other fractures or non-fracture injuries. Table 6b contains a listing of available OTA codes for specific lower-extremity injuries sustained by the 987 CIREN cases with at least one LEI. As shown, one AIS code may map to multiple OTA codes; however, not all AIS-coded fractures may be mapped to the OTA system. For instance, pelvic injuries, which account for the majority of AIS-coded LEI in CIREN, do not have a corresponding OTA code. Thus, although 2,472 AIS-coded LEI are documented in CIREN, only 1,210 of these LEI could be coded by the OTA system.

Table 6a - Distribution of All Lower-Extremity Injuries
All CIREN Centers (N=2,472)

Fracture	N	%
Pelvic	632	26
Femur	460	19
Patella	81	3
Tibia/Fibula	433	17
Ankle/Hindfoot	390	16
Tarsal/Metatarsal	152	6
Other	155	6
Non-Fracture injury (including dislocation)	169	7
Total	**2,472**	**100**

Table 6b - OTA Distribution of Lower-Extremity Injuries (anatomic location only)

All CIREN Centers Reporting (N=1,210)

Fracture	OTA Code (2 digits)	N	%
Proximal Femur	31	77	6.4
Femur Shaft	32	217	17.9
Distal Femur	33	59	4.9
Patella	45	55	4.6
Proximal Tibia	41	72	6.0
Tibia/Fibula Shaft	42	73	6.0
Ankle/Hindfoot (Distal tibia, malleolar segment, talus, calcaneus)	43, 44, 72, 73	384	31.7
Forefoot Tarsals/Metatarsals	74, 75, 76, 81	161	13.3
Non-Fracture Dislocations/Subluxations	30, 40, 46, 71D, 72D, 77D**, 80D**	112	9.3
Total		**1,210**	**100.0**

* Pelvic fractures are not OTA-coded in CIREN. The use of ICD-9 coding in CIREN allows for pelvic fractures to be detailed.

** These dislocations may involve several joints in the foot.

Hospital charges based on the four-way classification of CODES data parallel similarly stratified charges obtained from CIREN cases (figure 2). That is, both databases indicate a significantly increasing trend ($p < 0.001$) in incurred charges as the number of LEIs and involved body regions increase. Moreover, the two trends increase at a similar rate; hence the distributions of increasing charges within the two studies are statistically equivalent. As can be seen, charges for CIREN cases, treated in trauma centers, were significantly higher than the charges from the CODES data, which are based on averages from all hospitals. Level 1 trauma centers traditionally have higher costs of treatment due to a higher operating cost related to skilled health care specialists required to treat the most serious injuries and the technically advanced infrastructure required at such institutions.

Trends in median costs were tested using the Jonckheere-Terpstra test for ordered alternatives. The Kendall's partial rank-order correlation coefficient was calculated to compare the trend in costs between CODES and CIREN [18]. Pearson's chi-square statistic and Fisher's exact test were used to compare categorical data. A probability level (p-value) below 0.05 was considered statistically significant.

Figure 2 - Distribution of Median In-Hospital Charges in CODES and CIREN Databases

MD CODES Data 2000-2001, All CIREN Centers (Charges for Initial Admissions)

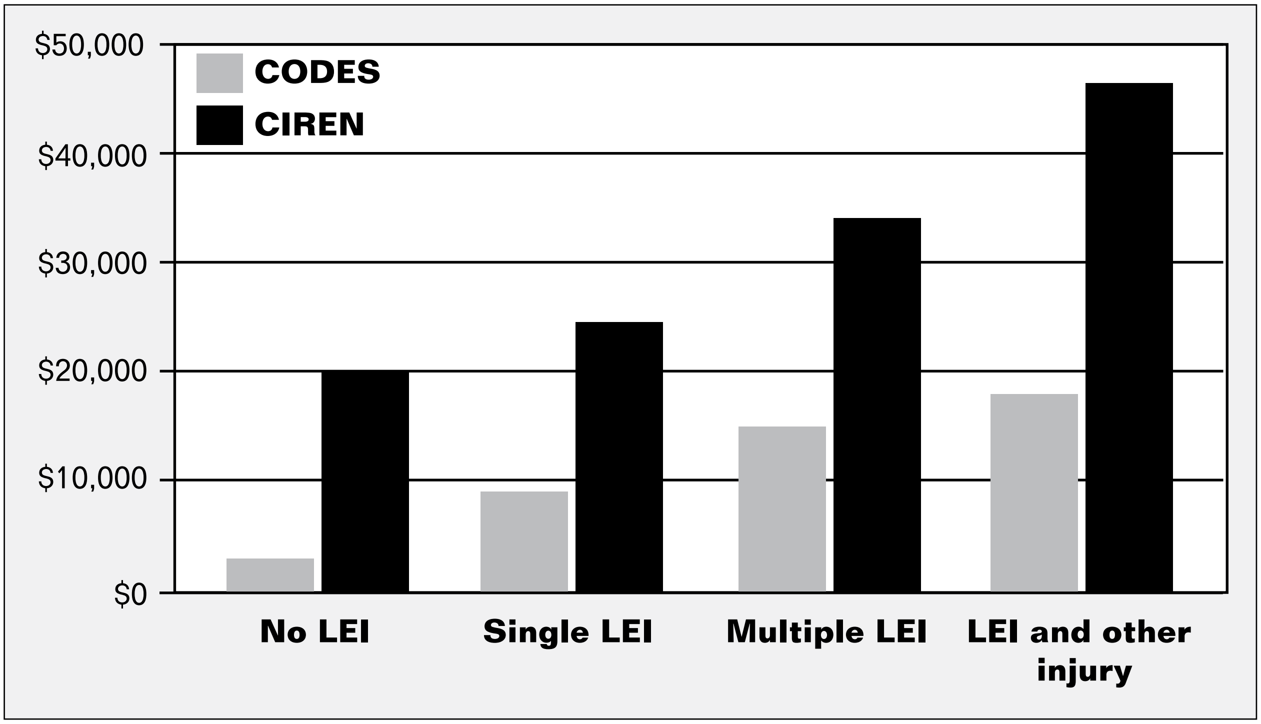


Table 7 - In-Hospital Median Charges for Single Lower-Extremity Injuries by OTA Code

All CIREN Centers (N=62)

Body Region	OTA Code	N	AIS Score	Median ($)	Articular*
Upper Leg	31B Femur Neck Fracture	1	3	48,910	No
	32A Femur Shaft Simple Fracture	17	3	20,695	No
	32B Femur Shaft Wedge Fracture	18	3	25,639	No
	32C Femur Shaft Complex Fracture	1	3	33,723	No
	33C Femur Distal Simple Fracture	3	3	67,134	Complete
Knee	45B Patella Fracture	1	2	17,733	Partial
Lower Leg	41B Tibia/Fibula Proximal Fracture	3	2	17,766	Partial
	41C Tibia/Fibula Proximal Fracture	2	2	40,052	Complete
Ankle	44B Tibia/Fibula Malleolar Fracture Transsyndesmotic	1	2	103,382	Complete
	44C Tibia/Fibula Malleolar Fracture Suprasyndesmotic Lesion	1	2	16,773	Complete
Foot	73B Calcaneus Fracture	1	2	9,370	No
	72A Talus Fracture	2	2	16,910	No
	72B Talus Fracture	2		35,460	Partial
	72D Subtalar Dislocation	2	2	24,259	No
	81A Metatarsal Shaft Proximal Fracture	6	2	3,109	No
	81C Metatarsal Proximal Fracture	1	2	12,010	Complete

* Complete articular involvement indicates 100 percent of the weight-bearing articular surface is disrupted. Partial articular involvement indicates that some part of weight-bearing articular surface is not disrupted.

As mentioned previously, OTA codes allow for more specific classification of fracture patterns, including disruption of articular surfaces, which often result in long-term disability. Table 7 details in-hospital charges for patients with a single lower-extremity injury according to the corresponding OTA code. This allows for greater distinction between fracture types within a given bone and for fractures with differing degrees of articular involvement. Even though the sample within each group is relatively small, fractures that include the articular surface, both partial and complete involvement, prove to have the higher in-hospital charges. For example, the median hospital charges for femur fractures without articular involvement ranged between $20,000 and $49,000, whereas a femur fracture having complete articular involvement cost, on average, more than $67,000. These differences in median hospital charges occurred despite the assignment of the same AIS score (i.e., AIS = 3) for each femur fracture.

III. Long-Term Consequences Of Motor-Vehicle-Related Lower-Extremity Injuries
(Maryland CIREN Center Data)

Methods

As of September 2003, 103 cases with at least one LEI injury were treated at the Maryland CIREN center and interviewed at baseline (time of injury) and subsequently at 6 and 12 months after injury. These cases form the basis of the analysis presented in the remainder of this report.

In CIREN, in addition to data obtained during the initial hospitalization period, detailed patient interviews are conducted at 6 months and 1 year post-injury as part of the project protocol. Information is collected regarding inpatient and outpatient rehabilitation therapy, repeat hospitalizations, ambulation problems, return to driving and return to employment. These interviews capture pre-injury health information and trauma history. The interviews include questions that measure depression, cognitive function, and Post Traumatic Stress Disorder (PTSD). The 36-Item Short-Form Health Survey (SF-36), a standardized generic questionnaire designed to show general health status, is also administered at 6 months and 1-year post-trauma.

As illustrated in figure 3, total median hospital and professional charges for Maryland CIREN cases approached $50,000 for the initial hospital stay. Charges associated with LEI patients who were admitted to an in-patient rehabilitation facility following their hospital admission were more than $10,000 higher than charges for patients who received out-patient therapy. Moreover, these estimates do not include charges associated with re-hospitalization or further rehabilitative care since some patients received follow-up care at outside facilities where data were not made available. Patients discharged to an in-patient rehabilitation facility remained there, on average, 3 weeks for therapy (range 1 to 24 weeks). Out-patient therapy usually lasted approximately 12 weeks (range 1 to 36 weeks).

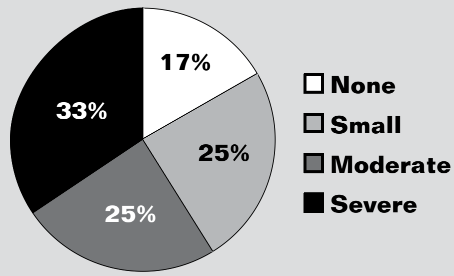
Despite the widely perceived "minor" nature of these injuries, the medical costs (in addition to other financial, familial, and pain and suffering costs) have a major financial impact on many families (see figure 3). Although most of the patients had insurance to cover their medical charges (62 percent private/HMO and 20 percent Medicare/Medicaid), 33 percent of these patients felt the financial impact of their injury was severe and caused hardships for themselves and their families due to loss of income and lack of adequate insurance coverage. Another 25 percent said the financial impact was moderate due to decreased income and large deductibles and co-pays. Only 17 percent of the group reported no financial impact due to excellent insurance coverage and little to no change in household income or expenses. However, this group was composed primarily of students and homemakers, who were not primary wage earners. By the 6-month interview, 56 percent of all LEI patients indicated that they were not receiving a continued salary or disability pay, while another 21 percent reported a need to rely on family members for their primary source of income.

Figure 3 - Median Charges and Financial Impact
Maryland CIREN Center (N=103)

Median Costs

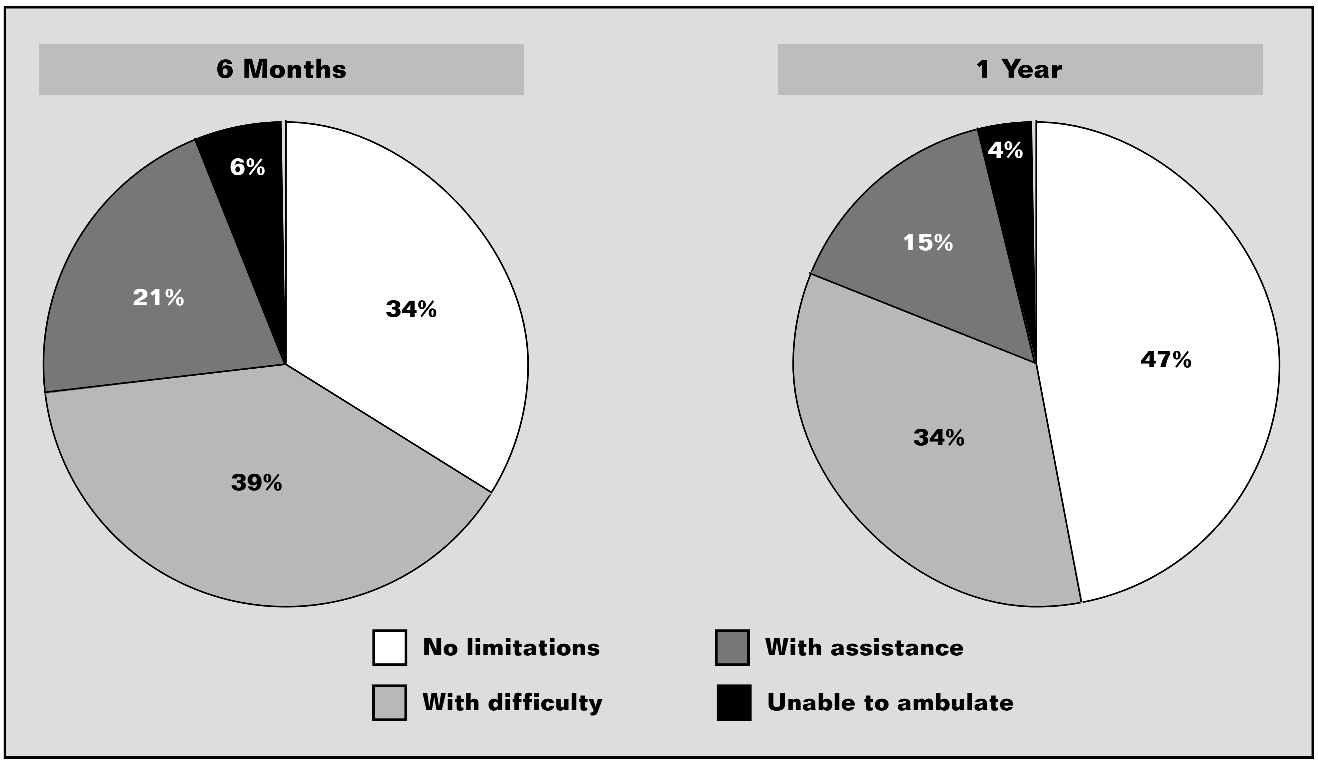
Hospital & Professional	$44,380
Inpatient Rehabilitation	$16,975
Outpatient Rehabilitation	$ 6,205

Financial Impact



At 6 months post-trauma, two-thirds of the patients reported problems with walking, required assistance in ambulation such as the use of a walker or cane, or were unable to bear weight and were confined to a wheelchair (figure 4). Almost 40 percent of the patients who were walking independently recounted having serious problems due to slow and painful gait or limp. By one year, 49 percent of the cohort continued to report difficulty with ambulation and 4 percent of the group were still not able to walk on their own. Issues such as pain and inability to bend, stoop, kneel, or climb stairs have a profound effect on work productivity, especially for those jobs requiring physical labor and/or activity necessitating being on one's feet a great deal, getting in and out of vehicles, or extensive walking. As the average age of these patients is around 30, these injuries also impact child-rearing and homemaking as well as careers for years to come.

Figure 4 - Ambulation Problems Among LEI Patients
Maryland CIREN Center (N=103)



Of all lower-extremity injuries, ankle and foot injuries have the most debilitating long-term effects. Thus, differences in long-term outcomes were also analyzed among LEI patients who did and did not incur an ankle or foot fracture, as defined by AIS score, since such injuries frequently involve articular surfaces. As shown in table 8a, LEI patients with an ankle/foot fracture incurred higher hospital, professional, and rehabilitation charges than did those without an ankle/foot fracture. In addition, patients with ankle/foot fractures were more likely than were those without such fractures to be re-hospitalized at least once within the 12-month period for circumstances related to their initial injury (table 8b). Approximately two-thirds of those who sustained ankle or foot fractures reported significant ambulation problems at 6 months and one year. Patients sustaining an ankle or foot fracture were also less likely to return to work or activities such as driving at 12 months post-trauma.

Table 8a - Ankle/Foot Fracture vs. No Ankle/Foot Fracture

Hospital, Professional and Rehabilitation Charges

Maryland CIREN Center (N=103)

	Ankle/Foot Fracture (N=50)	No Ankle/Foot Fracture (N=53)	p-value
Hospital + Professional (median $)	51,869	38,602	0.06
Inpatient Rehabilitation (median $)	20,000	13,095	0.11
Outpatient Rehabilitation (median $)	8,000	6,170	0.33
Hospital + Professional + Rehabilitation (median $)	76,904	50,328	0.02

Table 8b - Ankle/Foot Fracture vs. No Ankle/Foot Fracture

Long Term Outcomes – Physical Functioning

Maryland CIREN Center (N=103)

	Ankle/Foot Fracture (N=50)		No Ankle/Foot Fracture (N=53)		p-value
	n	%	n	%	
Re-hospitalization					
• At least once	28	56	15	28	0.004
Ambulation Problems					
• 6 months	38	76	30	57	0.040
• 1 year	34	68	21	40	0.004
Cannot return to driving					
• 6 months	22	44	14	27	0.07
• 1 year	14	28	10	19	0.27
Cannot return to work					
• 6 months	13	26	6	11	0.05
• 1 year	14	28	7	13	0.06

There was a high prevalence of psychological and sociological problems in the LEI group of 103 patients, although no differences were noted between those with and without ankle/foot fractures (table 8c). Psychosocial problems, such as PTSD, were evident in over 20 percent of all patients with LEI. Depression was a significant issue post trauma, affecting over one-third of the study group; patients with a pre-injury history of depression were twice as likely to exhibit symptoms of depression at 1 year post-trauma, prolonging their return to functioning.

Table 8c - Ankle/Foot Fracture vs. No Ankle/Foot Fracture

Long Term Outcomes – Psychosocial Functioning

Maryland CIREN Center (N=103)

	Ankle/Foot Fracture (N=50)		No Ankle/ Foot Fracture (N=53)		
	n	%	n	%	p-value
PTSD					
• 6 months	11	22	15	28	0.46
• 1 year	12	24	15	28	0.62
Patients with History of Depression	(n=19)		(n=21)		
• Depression at 6 months	13	68	11	52	0.30
• Depression at 1 year	11	58	14	67	0.57
Patients without History of Depression	(n=31)		(n=32)		
• Depression at 6 months	14	45	12	38	0.54
• Depression at 1 year	10	32	11	34	0.86
Behavioral Changes					
• 6 months	16	32	19	36	0.68
• 1 year	10	20	11	21	0.92
Cognitive Changes					
• 6 months	16	32	17	32	0.99
• 1 year	15	30	18	34	0.67
Pain					
• 6 months	34	68	31	58	0.32
• 1 year	28	56	23	43	0.20

Cognitive problems (difficulty with concentration, attention and memory) were also experienced by 30 percent of patients and behavioral changes, such as increased irritability or personality changes, were reported for 20 percent of the group. Joint pain, still experienced by more than one-half of patients at 1 year post-trauma, also contributed to a delay in return to work or poorer work performance. For both in-patient and out-patient aspects of their treatment, those with an articular ankle/foot fracture incurred higher charges than those with a non-articular ankle/foot fracture (table 9). These differences are seen in both acute hospital and professional charges and out-patient rehabilitation, which supports the conclusion that fractures involving articular surfaces are more costly, especially after the patient leaves the hospital, than those that are non-articular in nature.

Table 9 - Involvement of Articular Surface in Ankle/Foot Fractures

Maryland CIREN Center (N=50)

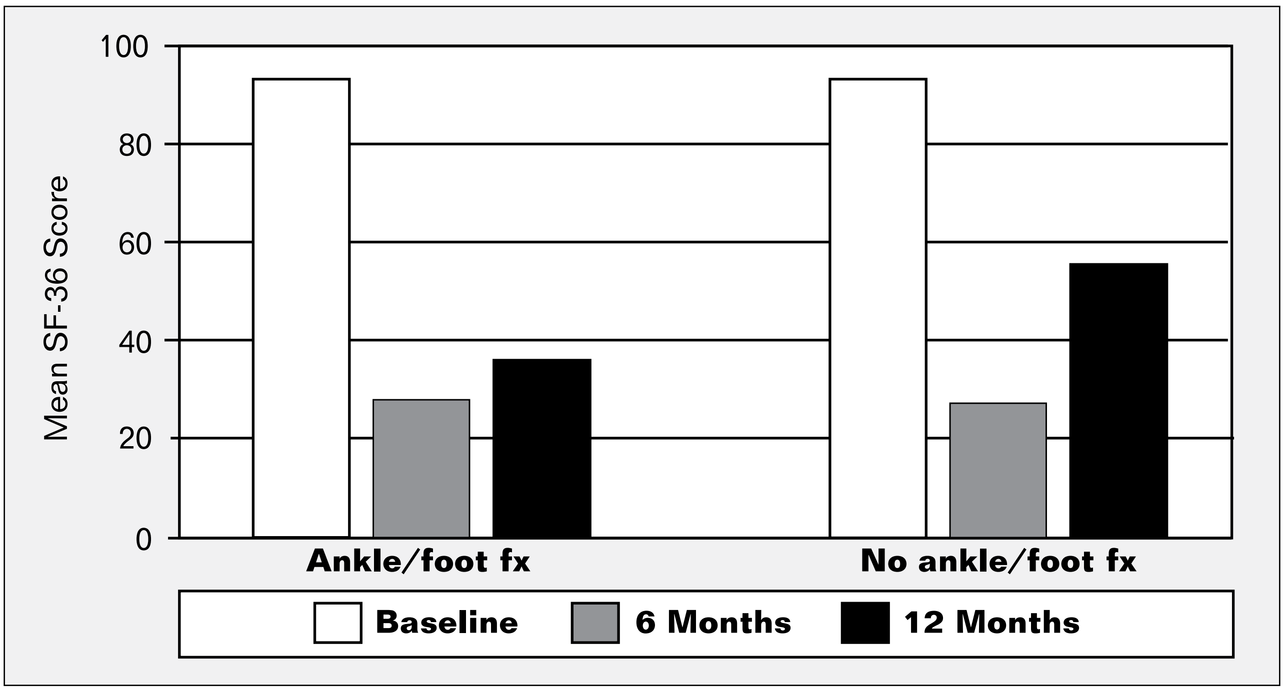
	Articular (N=42) Median	Non-Articular (N=8) Median	p-value
Hospital + Professional Charges	$55,704	$35,553	0.12
Inpatient Rehabilitation Charges	$20,500	$19,388	0.51
Outpatient Rehabilitation Charges	$8,880	$3,570	0.30
Hospital + Professional + Rehabilitation	$78,694	$37,439	0.08

Further evidence of the debilitating nature of ankle/foot injuries can be shown by results of the SF-36. The SF-36 provides a measurement of eight health concepts, or domains, related to physical and social functioning. Scores for each domain range from 0 to 100, with a higher score indicating a more positive outcome. For each domain, results indicated that patients generally declined in function from baseline to 6 months post-trauma before improving slightly at 12 months, to below baseline levels. With the exception of the domain of *role physical*, (which measures physical problems in performing daily and work-related activities), this trend occurred within both the ankle/foot and no ankle/foot fracture groups.

Figure 5 summarizes the interaction between fracture occurrence and *role physical* functioning over time. Patients without an ankle or foot fracture scored twice as high at 12 months than at 6 months. However, those with an ankle/foot fracture exhibited almost no improvement between 6 and 12 months.

Figure 5 - Role Physical Mean Scores According to Fracture Group Changes Over Time

Maryland CIREN Center (N=103)



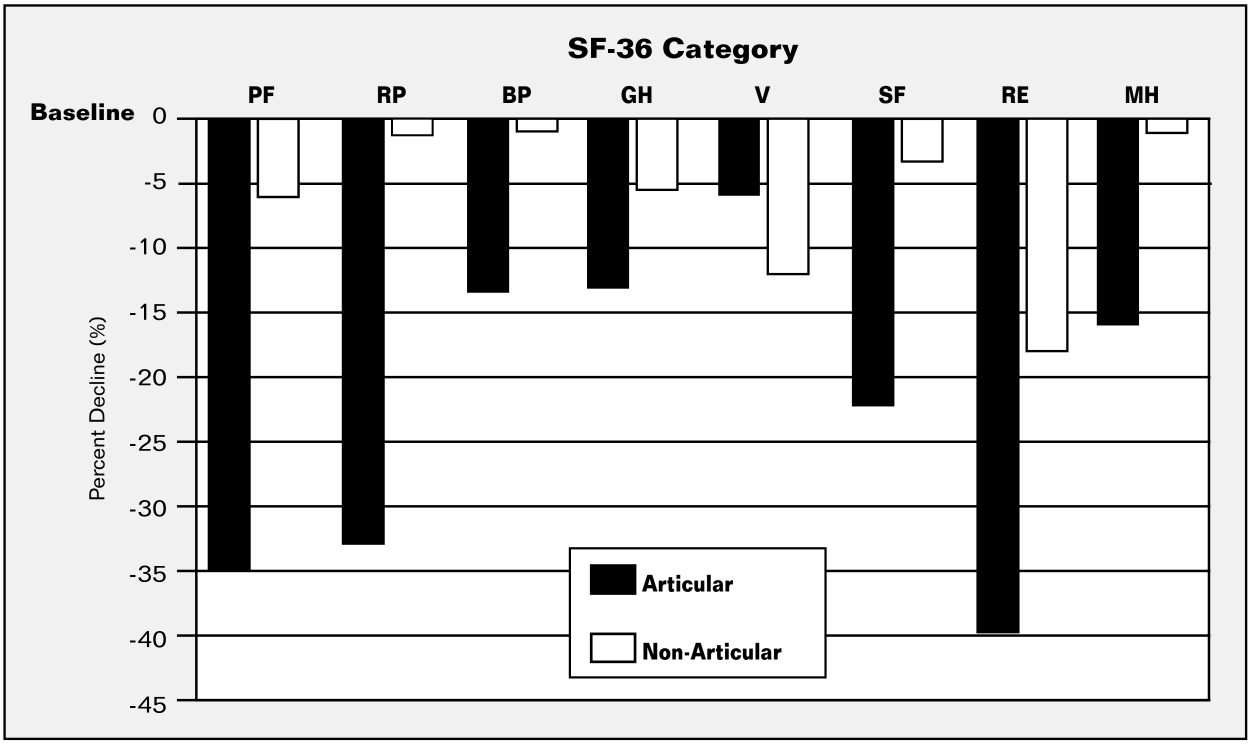
Finally, to further illustrate the significant, and frequently long-term, burden associated with lower extremity injuries, 10 CIREN cases are presented as follows. In each case, the only significant injury (AIS>=2) was an isolated lower-extremity injury. Patients with isolated LEI were selected in an attempt to find a more "pure" estimate of consequences and costs associated with a given type of fracture. These cases provide a cross-section of crash victims with similar injuries who are faced with similar economic and psychosocial burdens for a substantial period of time following their initial medical care.

A synopsis of each of the 10 cases, including charges and long-term outcomes, is presented in the Appendix. Individual case studies are presented, including crash pictures, injury descriptions, radiographic images, and SF-36 scores at baseline, 6 months and 1-year post-injury. Additional information is obtained by interview regarding (a) pre-injury health information and trauma history, (b) two questions that measure depression [19], (c) a screening tool for assessment of alcohol and drug use, (d) questions regarding cognitive function, (e) items meeting the diagnostic criteria for PTSD [20], and (f) a numeric pain intensity scale [21]. In addition, the appendix provides a summary of outcomes and charges for this group of 10 patients. It should be noted, however, that these cases, while representative of a cross-section of types of lower-extremity injuries, may reflect an underestimate of the associated costs and outcome problems, as they do not include patients with bilateral injuries or serious brain injury. Yet cognitive problems were evident at 1-year post-injury for 3 patients. Additionally, 5 patients were experiencing symptoms of depression affecting their quality of life and feelings of well-being. Patients who experience a more complicated course may be expected to have further problems that impede recovery.

Although all 10 cases required rehabilitative therapy, it should be noted that those patients who sustained serious injury involving articular (joint) surfaces (see cases 1-5) had poorer outcomes at one year. Each of these cases (who had injuries with AIS>=2) had problems with ambulation and ongoing pain at 1-year post-injury. Four out of 5 patients exhibited slow, painful gaits, difficulty climbing stairs, or walking any distance. Each had been employed full-time prior to their crash, but none were eligible to receive any wages or disability income. Three of these patients were still unemployed at 1 year, due to their inability to perform job functions following their injuries. Since patients with a single lower-extremity injury are usually discharged to home, they nonetheless required out-patient therapy 3 to 5 times a week, lasting up to 6 months post-injury. Case 5, however, did not have out-patient therapy due to lack of insurance coverage, despite medical recommendation.

Figure 6 summarizes the health domains of the 10 cases. In contrast to the customary SF-36 graph, this chart was chosen to identify the mean percent decline in each category at 1 year as compared to their baseline score. For each domain, all patients declined in function from baseline to 1-year post-trauma. However, despite small numbers in each group, patients with articular injuries fared worse than those with non-articular injuries.

Figure 6 - SF-36: Percent Decline From Baseline to 1-Year by Articular Involvement (N=10)



Thus, in summary, crash victims with lower-extremity injuries have higher hospital charges than those without LEI. Initially, those with fractures of the long bones have higher associated costs. Also, within a given fracture type (e.g., ankle), those with articular damage have higher in-hospital charges than those without (table 9). However, upon examination of long-term impact (post-hospital discharge) it is apparent that those with ankle/foot fractures (the majority of whom have an injury with AIS=2) fare considerably worse at 1 year in terms of ability to return to pre-injury functioning. This is especially true for those with articular disruption, such as that seen in pilon fractures.

Discussion

These findings illustrate the high incidence of lower-extremity injuries incurred in motor vehicle crashes and their staggering associated consequences and costs. In fact, with the evolution of modern occupant restraints, there has been a relative increase in the burden of these injuries due to the fact that more drivers who survive high-energy crashes (and previously did not) still sustain LEI. Total hospital charges for drivers and passengers in Maryland in the year 2000 were estimated to be $49 million, of which approximately $21 million (43 percent) were attributable to patients with LEI, up from 40 percent in 1988 [22]. By 2001, statewide charges associated with hospitalized vehicular occupants had increased to $56 million, of which approximately $25 million (45 percent) were attributable to patients with LEI.

Previous studies addressing the cost of lower extremity injury have concluded that costs increase with increasing AIS scores [23]. However, these analyses have usually been based strictly on injury documentation from “administrative” or hospital discharge records, which do not have the advantage of the degree of clinical insight and thus, detail, documented in CIREN. In addition, many analyses related to costs address only the acute care costs associated with the initial hospitalization, thereby missing the long-term costs associated with rehabilitation, repeated surgeries, job loss, and impairment of mobility. These longer-term and indirect costs frequently dwarf those associated with acute care despite the fact that many patients who experience difficulties in returning to pre-injury functioning have injuries with an AIS score equal to two.

The primary costs to patients with articular injuries are reflected in their inability to return, or lengthy delay in returning, to pre-injury activities such as driving, employment, household maintenance, or leisure-time activities. This increased dependence, in conjunction with decreased income and continued legal issues, frequently complicates the recovery process and can lead to symptoms of depression and post-traumatic stress.

These social “costs,” although indirect, difficult to measure, and difficult to assign a dollar value, impede the recovery process. Now that more and more people survive high-energy crashes due to state-of-the-art vehicles, pre-hospital transport, and trauma care systems, it is paramount that adequate treatment be provided to address these clinical issues and reduce societal costs both in the workplace and at home.

Furthermore, financial debts and altered lifestyle impact not only the patient but the patient’s family and other caregivers, extending burdens such as time lost from work, transportation costs, and other issues such as child-rearing to other family members. Thus, costs attributable to the crash are not limited to the injured party per se, but also impact their family members, community, and society in general.

Injury severity scales that reflect disability need to more accurately capture the fact that fractures involving articular surfaces frequently have the greatest long-term consequences on patients’ return to pre-injury functioning. In fact, such an effort is already under way by the Association for the Advancement of Automotive Medicine (AAAM), a professional multidisciplinary organization dedicated entirely to motor vehicle crash injury prevention and control. As previously explained, AIS codes, the standard for most injury research, were originally based on mortality, not morbidity, and therefore do not adequately reflect long-term disability. However, AAAM, working with CIREN researchers, is currently developing an updated AIS coding system that incorporates the articular nature of fractures. This new system will assign more specific severity codes based on threat to life as well as extent of disability.

These data highlight the uniqueness of the CIREN program, with its ability to document detailed injury and crash information, including long-term outcomes. Without the detailed classification presented by the OTA data in addition to long-term outcome data, it would not be possible to illustrate the significantly higher burden imposed by articular fractures, and it would be easy to conclude, mistakenly, that fractures of long bones, with higher AIS scores, are the more costly injuries.

These findings strengthen the need for primary prevention, which in turn must be based on a comprehensive understanding of the biomechanics of lower extremity injury. From real-world findings noted among patients admitted to trauma centers, CIREN engineering/biomechanics experts are working to replicate these injuries, using tools such as computer simulation or dummy crash test experiments. Moreover, engineers from the automotive industry are using CIREN insights into the crash injuries to improve safety performance.

Many lower-extremity injuries are sustained in crashes with little or no intrusion. However, crash reconstruction data and simulation results suggest that factors such as a vehicle's change in velocity as well as rate and timing of intrusion must be considered when examining LEI injury mechanisms.

Hopefully, this report advances understanding of the life-altering impact of these injuries on individuals, families, and society.

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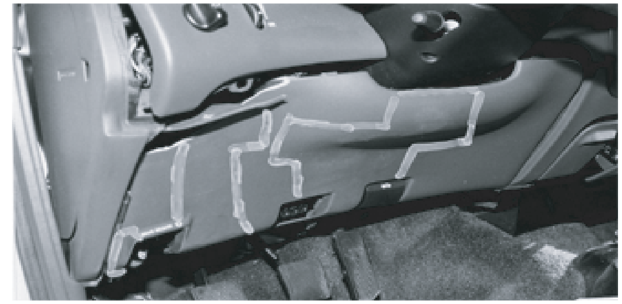
Appendix of LEI Case Summaries

CASE 1 CRASH

- 35-year-old, 5'9", 190 lb. single male driver of 1996 Ford Ranger involved in two-vehicle crash impacting tree
- Single occupant, unbelted driver/AB deployed
- Principal Direction of Force (PDOF) = Frontal
- Delta V (DV) = 39 mph

Point of Impact



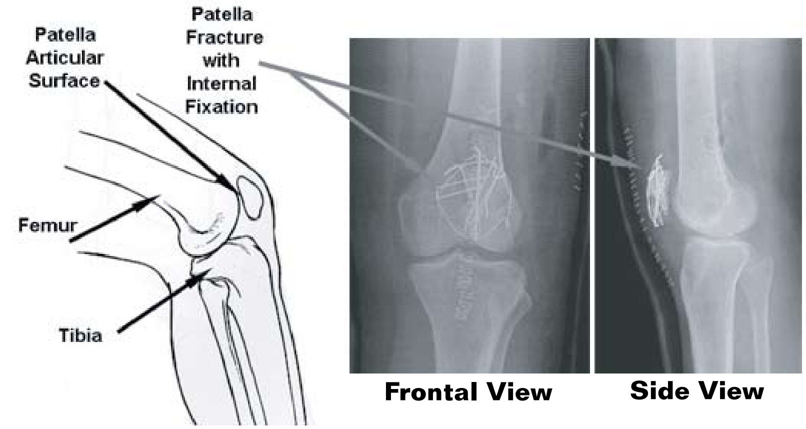
Injury Source - Instrument Panel

PRE-INJURY HISTORY

- Past medical history (PMHx): Not significant
- Psychosocial History (Psy So Hx): Substance abuse
- Self-employed, owner of a lawn care/landscaping business
- Private health insurance
- Lives alone

INJURY/ HOSPITAL

- **Left articular patella fracture (fx) (closed)**
  MAIS = 2 / OTA code = 45C
- Glasgow Coma Score (GCS) = 15, No Loss of Consciousness (LOC)/ No amnesia
- Toxicology (TOX) = Negative
- Acute Hospitalization Length of Stay (LOS) = 5 days
- Internal fixation (wiring) of patella fx
- Discharge (D/C) = Home with outpatient therapy



Frontal View **Side View**

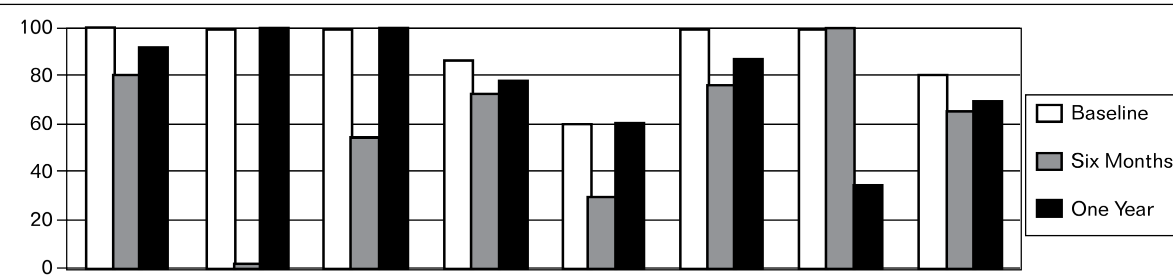
POST-TRAUMA OUTCOMES

- Outpatient rehabilitation = 3x weekly for 16 weeks
- No disability income, lost wages, unable to pay health insurance premiums
- Return to work @ 18 weeks with job modifications due to mild pain issues and physical limitations in performing vigorous activity, stair climbing, bending and stooping limited
- Sustained business losses as out of work for 18 weeks
- Forced to give up own apartment and relocate with relatives due to financial hardship
- Legal issues unresolved @ 1 year
- Positive for depression
- Increased use of alcohol

COST (CAPTURED CHARGES ONLY)

Hospital	$ 14,322
Professional	$ 3,610
Rehabilitation - OP	$ 6,240
Total	**$ 24,172**

SF-36



PF = Physical Functioning
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 2 CRASH

- 64-year-old, 5'2", 176 lb. married female passenger of 1998 GMC Safari involved in two-vehicle crash.
- Fatality at scene in the other vehicle.
- Right front passenger, belted /AB deployed
- PDOF = Frontal
- DV = 25 mph

Point of Impact

Injury Source - Instrument Panel

PRE-INJURY HISTORY

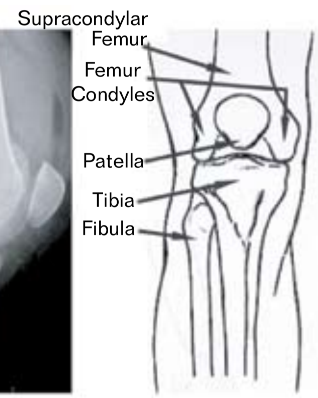
- PMHx: Not significant
- Psy So Hx: Not significant
- Self-employed/patient and husband owners of family business

INJURY/ HOSPITAL

- **Right lower end articular femur fx (closed)**
  MAIS = 3 / OTA code = 33B1.1
- GCS = 15, No LOC/No amnesia
- TOX = negative
- Acute hospitalization LOS = 6 days
- Internal fixation of femur fx
- D/C = Inpatient rehabilitation facility

Anterior View - Injury X-Ray

Lateral View - Injury X-Ray



Anterior View - Anatomic Knee

Plate and screw fixation of the distal femur fracture

Anterior View X-Ray

Medial View X-Ray

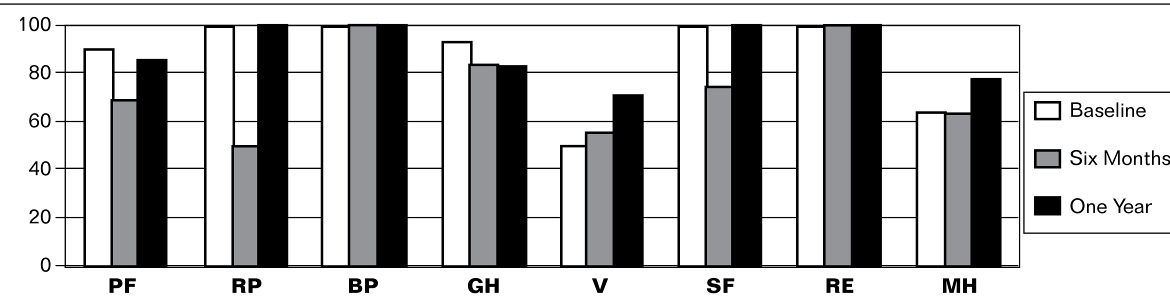
POST-TRAUMA OUTCOMES

- Inpatient rehab for 3 weeks
- Outpatient rehab = 3x weekly for 24 weeks
- Decreased family income due, business losses secondary to therapy commitments and physical impairment during first six months post injury
- No disability income
- Legal issues unresolved @ 1 year
- Altered life view/patient chose not to return to work, evoking some marital discord.
- Patient ambulating with minor problems @ 1 year (minor pain/arthritis)

COST (CAPTURED CHARGES ONLY)

Hospital	$ 30,303
Professional	$ 4,986
Rehabilitation - Inpatient (IP)	$ 11,383
Rehabilitation - Outpatient (OP)	$ 9,360
Total	**$ 56,032**

SF-36



PF = Physical Functioning
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 3 CRASH

- 35-year-old, 5'5", 200 lb. married female driver of a1997 Chevrolet Blazer involved in an intersection crash where other vehicle ran a red light.
- Single occupant, belted driver/AB deployed
- PDOF = Frontal/partial rollover
- DV = 12 mph

Point of Impact

Injury Source - Instrument Panel

PRE-INJURY HISTORY

- PMHx: Obesity, lower back pain/vertebral disc problems
- Psy So Hx: Patient lost job 4 months prior to admission, depression, anxiety
- Homemaker/mother of 14-month-old child, recently established home business and delivery service in basement of home to supplement family income.
- History of depression
- Three prior motor vehicle crashes

INJURY/ HOSPITAL

- **Right upper end articular tibia fx (closed)** MAIS = 3 / OTA code = 41B3.1
- GCS = 15, positive LOC and amnesia to event
- TOX = negative
- Positive pregnancy test
- Acute hospitalization LOS = 5 days
- Internal fixation of tibia fx (intramedullary rodding)
- D/C = Home with outpatient therapy

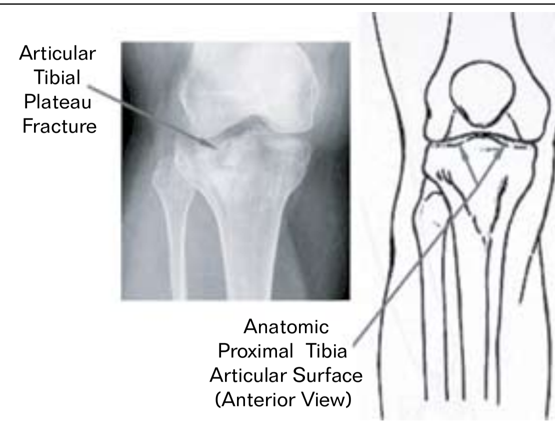


Plate & Screw Fixation of Tibial Plateau Fracture

Anterior View X-Ray **Lateral View X-Ray**

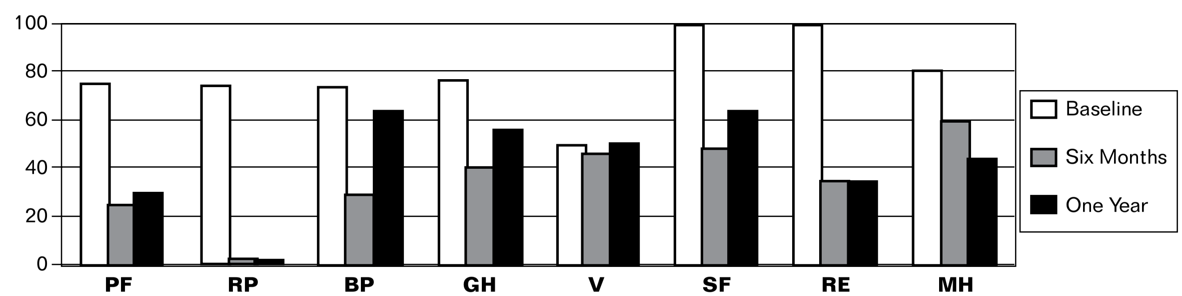
POST-TRAUMA OUTCOMES

- Outpatient rehab = 3x weekly for 4 weeks
- Miscarriage post-trauma
- Painful, slowed gait with pronounced limp, balance problems
- Patient remains unemployed, home business dissolved due to difficulty climbing stairs and getting in and out of car frequently
- Legal and financial problems persist @ 1 year
- Positive for depression, body-image issues
- Positive for cognitive problems (memory lapses, concentration)
- Positive for mild PTSD

COST (CAPTURED CHARGES ONLY)

Hospital	$ 26,986
Professional	$ 4,270
Rehabilitation - OP	$ 1,920
Total	**$ 33,176**

SF-36



PF = Physical Functioning
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 4 CRASH

- 31-year-old, 5'6", 185 lb. married male driver of 1997 Kia negotiating curved roadway when vehicle ahead stopped to make left turn. Case vehicle, steering right to avoid hitting curb, lost control and struck a tree
- Single occupant, belted driver/AB deployed
- PDOF = Frontal
- DV = 26
- Positive for alcohol and marijuana on admission
- Sleep deprivation

Point of Impact

Injury Source - Floor Pan

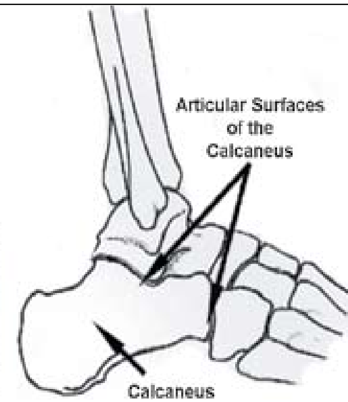
PRE-INJURY HISTORY

- PMHx: Not significant
- Psy So Hx: Substance abuse
- Employed as laborer in warehouse
- No health insurance
- Remarried 6 months prior to admission

INJURY/ HOSPITAL

- **Right articular calcaneus fx (closed)**
  MAIS = 2 / OTA code = 73C
- GCS = 15, No LOC/No amnesia
- TOX = positive
- Acute hospitalization LOS = 4 days
- Internal fixation (plate and screws) of calcaneus fx
- D/C = Home with outpatient therapy

Lateral Foot Injury X-Ray



Internal Plate and Screw Fixation of the Calcaneus

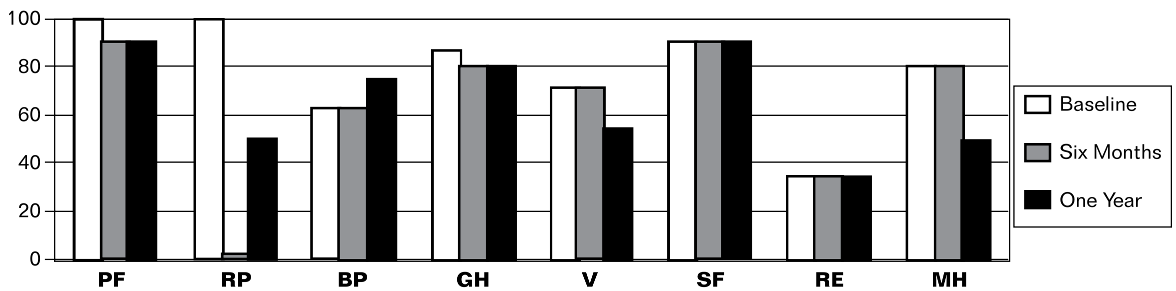
POST-TRAUMA OUTCOMES

- Outpatient therapy = 3x weekly for 12 weeks
- Ambulates with limp and painful gait
- Difficulty climbing stairs/standing and walking long distances
- Unable to return to former job due to injury
- Increased substance use and anxiety, unable to drive

COST (CAPTURED CHARGES ONLY)

Hospital	$ 7,420
Professional	$ 1,250
Rehabilitation - OP	$ 4,780
Total	**$ 13,450**

SF-36



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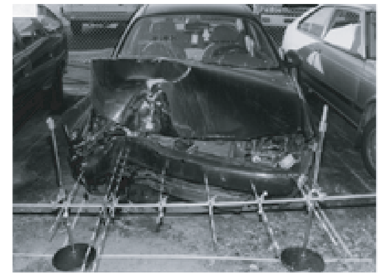
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 5
CRASH

- 40-year-old, 5'2", 230 lbs. single female driver of 1997 Ford Escort who admits to being distracted thinking about father who was ill, lost control of vehicle, hitting pole.
- Single occupant, belted driver/AB deployed
- PDOF = Frontal
- DV = Unable to be determined



Point of Impact

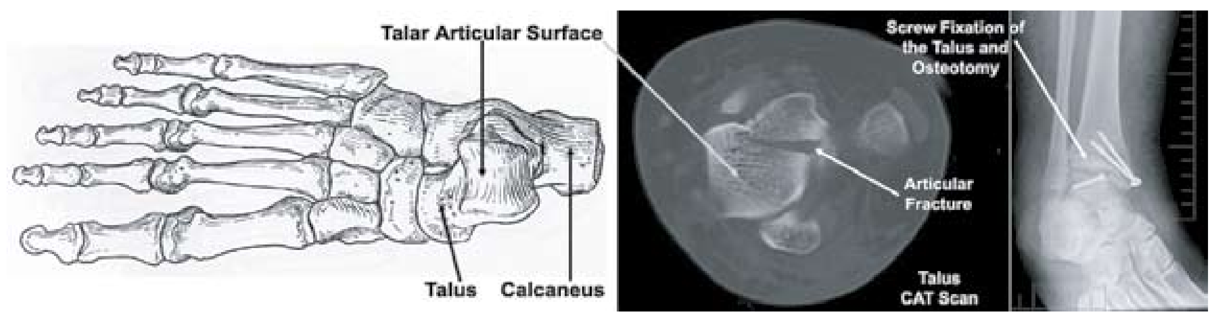
Injury Source - Floor Pan

PRE-INJURY HISTORY

- PMHx: Migraines/Blackouts
- Psy So Hx: Depression, Substance Abuse, Smoker
- Full-time daycare provider
- No Health Insurance
- Lives w/daughters, age 19 & 22 (a son died in car crash @ age 14, five years prior to admission)

INJURY/ HOSPITAL

- **Right articular talus fx (closed)** MAIS = 2 / OTA code = 72B
- GCS = 15, Positive for amnesia of event
- TOX = negative
- Acute hospitalization LOS = 4 days
- Internal fixation of talus fx with medial malleolar osteotomy
- D/C = Inpatient rehabilitation facility



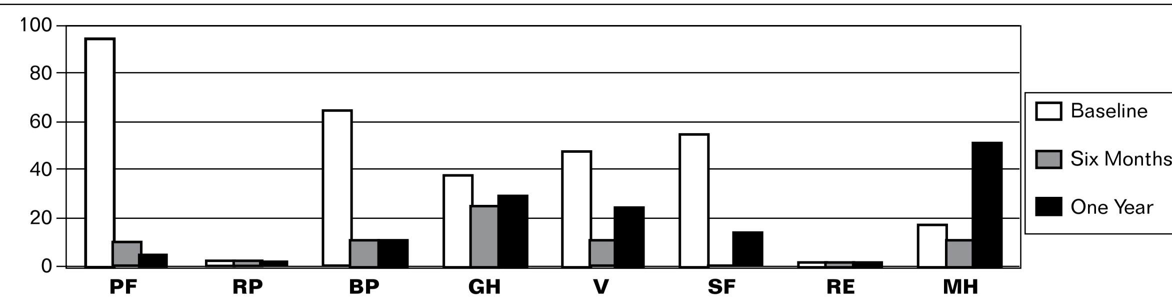
POST-TRAUMA OUTCOMES

- Inpatient rehabilitation for 2 weeks
- No outpatient therapy due to lack of insurance
- Lost wages, no disability income
- Unemployed and unable to return to work due to injury
- Applied for Social Services assistance and food stamps out of necessity
- Ambulates with assistance, painful slow gait
- Legal issues continue @ 1 year
- Increased use of alcohol
- Positive for depression and symptoms of PTSD

COST (CAPTURED CHARGES ONLY)

Hospital	$ 24,270
Professional	$ 3,600
Rehabilitation - IP	$ 11,701
Total	**$ 39,571**

SF-36



PF = Physical Functioning
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 6
CRASH

- 77-year-old, 5'6", 138 lbs. married female, driver of 1998 Geo Metro failed to yield right-of-way while making left turn and was T-boned on passenger side
- Single occupant, belted driver/AB deployed
- PDOF = Farside/Lateral
- DV = 22 mph

Point of Impact

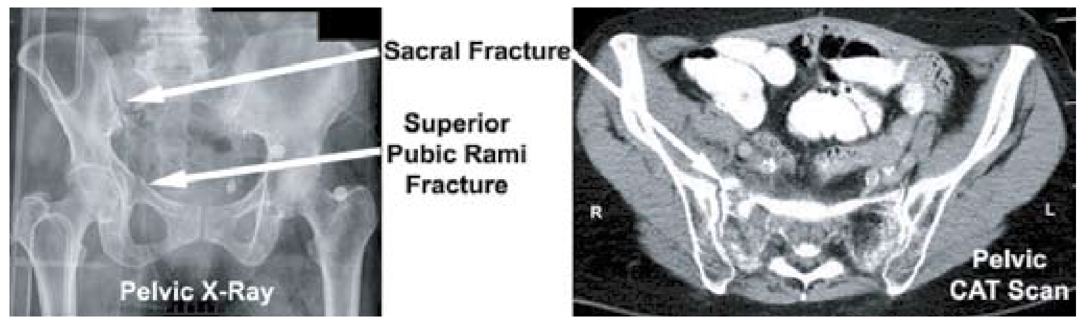
Injury Source - Seat Belt

PRE-INJURY HISTORY

- PMHx: Hypertension, Ovarian Cancer, Colectomy
- Psy So Hx: Depression
- Retired administrative assistant
- Medicare and private health insurance
- Lives with husband (disabled due to stroke), patient is primary caretaker

INJURY/ HOSPITAL

- **Pelvic fx**
  MAIS = 2 / OTA code = 61B2.1
- GCS = 15, No LOC/No Amnesia
- TOX = negative
- Acute hospitalization LOS = 8 days
- Pelvic fx treated non-operatively
- D/C = Inpatient rehabilitation facility



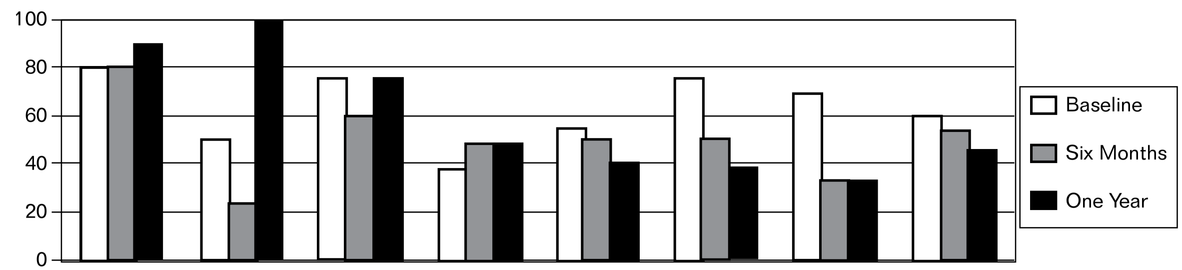
POST-TRAUMA OUTCOMES

- Inpatient rehab for 2 weeks
- Outpatient therapy = 3x weekly for 8 weeks, dependent on friends for transportation
- Returned to driving @ 16 weeks
- No ambulation limitations but mild pain evidenced
- Decreased energy; fatigue
- Requires assistance caring for husband, hired nurse/companion.
- Increased financial concerns. Need to sell family home and consider assisted-living housing due to husband's deteriorating condition and patient's inability to assume full caretaking role.
- Positive for depression
- Physical functioning improved due to decreased caretaking responsibilities, improved general health

COST
(CAPTURED CHARGES ONLY)

Hospital	$ 16,333
Professional	$ 3,266
Rehabilitation - IP	$ 10,635
Rehabilitation - OP	$3,120
Total	**$ 33,354**

SF-36



PF = Physical Functioning
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 7
CRASH

- 61-year-old, 5'8", 165 lb. married male driver of 2002 Mercury Grand Marquis hit head-on when other vehicle crossed center line.
- Belted driver/AB deployed
- PDOF = Frontal
- DV = 20 mph

Point of Impact

Injury Source - Instrument Panel

PRE-INJURY HISTORY

- PMHx: Not significant
- Psy So Hx: Primary provider and caretaker of wife, who is partially disabled due to diabetes and heart condition, as well as mentally ill adult son and his children.
- Employed full-time/physical labor

INJURY/ HOSPITAL

- **Left upper end of femur fx (closed)**
  MAIS = 3 / OTA code = 32C3.3
- GCS = 15, No LOC/No amnesia
- Acute hospitalization LOS = 8 days
- Internal fixation of femur fx (intramedullary rodding)
- Experienced a pulmonary embolism, a frequent complication with femur fractures but often not recognized
- D/C = Home with outpatient therapy

Segmental Femur Fracture

Femur Fracture Post Intramedullary Rodding

Femur Fracture (5 months post crash)

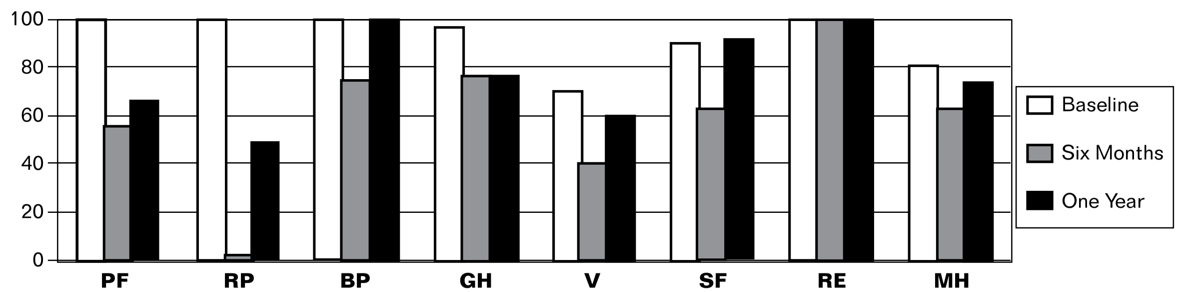
POST-TRAUMA OUTCOMES

- Outpatient rehab for 18 weeks.
- Re-hospitalization due to blood clot secondary to crash
- Wife re-hospitalized due to cerebral vascular accident (CVA)
- Disability pay expired and patient could no longer afford monthly COBRA health insurance premiums.
- Patient returned to work @ 25 weeks; forced to hire caretaker/companion for wife
- Altered life style

COST (CAPTURED CHARGES ONLY)

Hospital	$ 35.899
Professional	$ 6,580
Rehabilitation - OP	$7,020
Total	**$ 49,499**

SF-36



PF = Physical Functioning
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 8
CRASH

- 20-year-old, 5'9", 185 lb. single male driver of 1996 Ford Escort involved in two-vehicle crash
- Single occupant, belted driver/AB deployed
- PDOF = Frontal
- DV= 28 mph

Point of Impact

Injury Source - Instrument Panel

PRE-INJURY HISTORY

- PMHx: Not significant
- Psy So Hx: Smoker
- Full-time student at community college
- Volunteer firefighter
- Lives at home with parents and younger sibling

INJURY/ HOSPITAL

- **Right femur shaft fx (closed)**
  MAIS = 3 / OTA code = 32C1.1
- GCS = 15, some amnesia to event and altered consciousness
- TOX = negative
- Acute hospitalization LOS = 5 days
- Internal fixation of femur fx intramedullary rodding)
- D/C = Home with outpatient therapy

Femur Shaft Fracture (Front View)

Femur Fracture with Intramedullary Rod Fixation

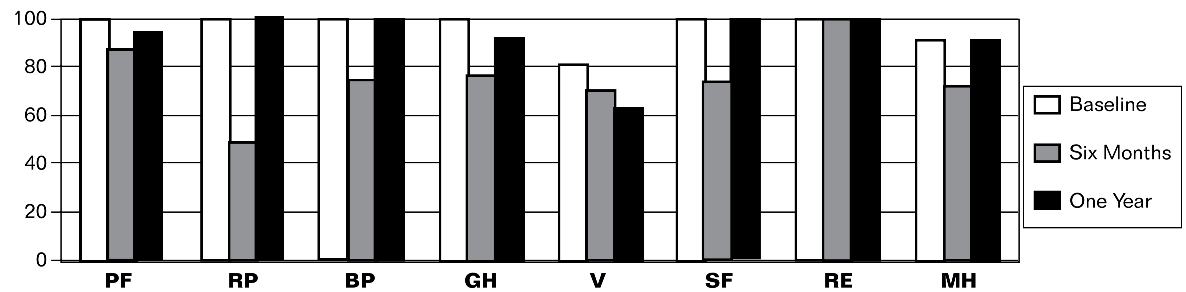
POST-TRAUMA OUTCOMES

- Outpatient rehab = 2x weekly for 18 weeks
- Return to full-time student status @ 20 weeks, lighter course load due to concentration problems
- Decreased volunteer hours @ fire department due to sleep disturbances secondary to crash
- No ambulation problems/occasional balance issues
- Experiencing cognitive difficulties (recall, sequencing tasks)

COST (CAPTURED CHARGES ONLY)

Hospital	$ 41,255
Professional	$ 10,537
Rehabilitation - OP	$3,200
Total	**$ 54,992**

SF-36



PF = Physical Functioning
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 9
CRASH

- 18-year-old, 6'3", 145 lb. single male driver of 1997 Geo Metro lost control of vehicle due to ice and slush on roadway, crossing into on-coming traffic and striking another vehicle.
- Single occupant, belted driver/AB deployed
- PDOF = Frontal
- DV = 24 mph

Point of Impact

Injury Source - Instrument Panel

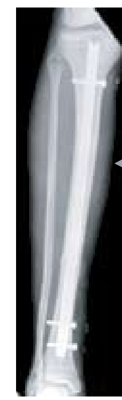
PRE-INJURY HISTORY

- PMHx: Chronic bronchitis
- Psy So Hx: Attention deficit with hyperactivity disorder; bi-polar disorder
- Works full time at fast-food restaurant and attends vocational school
- Private health insurance
- Lives with mother, who recently separated from father, and two brothers
- Recent stressors: parental separation, grandfather's death, break-up with girlfriend

INJURY/ HOSPITAL

- **Right tibia & fibula shaft fx (open)**
  MAIS = 3 / OTA code = 42A3.3
- GCS = 15 with No LOC/No amnesia
- TOX = Negative
- Acute hospitalization LOS = 3 days
- Internal fixation of tibia fx (intramedullary rodding)
- D/C = Home with outpatient therapy

Tibia and Fibula Transverse Shaft Fracture (Side View)



Tibia Fracture with Intramedullary Rod Fixation (Front View)

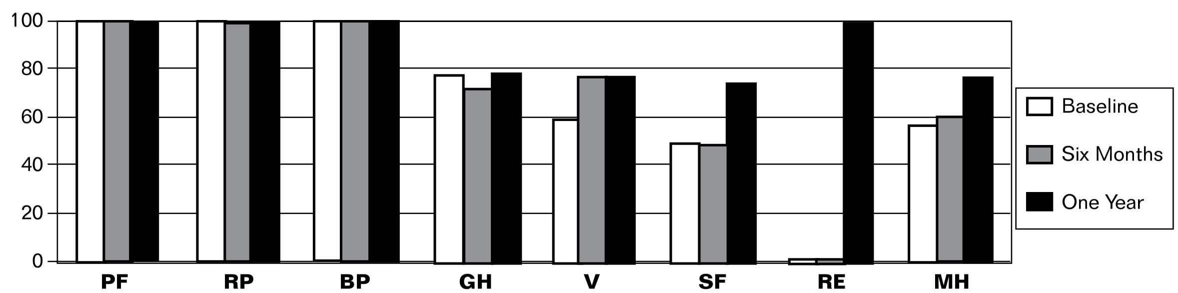
POST-TRAUMA OUTCOMES

- Outpatient rehabilitation = 2x weekly for 2 weeks
- Health insurance coverage denied
- Return to work at 5 weeks; unable to return to school due to emotional problems exacerbated since crash
- No ambulation limitations
- Legal issues unresolved @ 1 year
- Positive screen for PTSD @ 6 months, negative @ 1 year

COST
(CAPTURED CHARGES ONLY)

Hospital	$ 11,623
Professional	$ 4,436
Rehabilitation - OP	$ 780
Total	**$ 16,839**

SF-36



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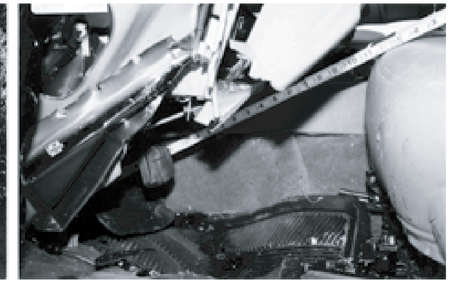
RP = Role Physical
BP = Body Pain (absence of)
GH = General Health
V = Vitality
SF = Social Functioning
RE = Role Emotional
MH = Mental Health

CASE 10
CRASH

- 16-year-old, 6’ 153 lb. single male driver of a 2002 Mercury Mountaineer lost control of vehicle due to inclement weather and struck a tree. He was entrapped by the steering wheel and brake.
- Single occupant, belted/no AB deployment
- PDOF = Partial rollover/roof
- DV = Not able to be determined

Point of Impact



Injury Source - Foot Pedals

PRE-INJURY HISTORY

- PMHx: Not significant
- Psy So Hx: Patient had drivers license for 1 month
- High school junior, good student, varsity athlete (potential college athletic scholarship)
- Large group of friends, supportive family
- Patient lives with parents and younger sibling

INJURY/ HOSPITAL

- **Left tibia shaft fx (open)**
  MAIS = 3 / OTA code = 42A3.1
- GCS = 15, No LOC/No Amnesia
- TOX = negative
- Acute hospitalization LOS = 4 days
- External fixation of tibia fx
- D/C = home with outpatient therapy

Tibia X-Ray (Side View) Transverse Tibia Shaft Fracture

Tibia Fracture Post External Fixation

Tibia Fracture 2 Months Post Crash

Tibia Post External Fixation Removal (5 months)

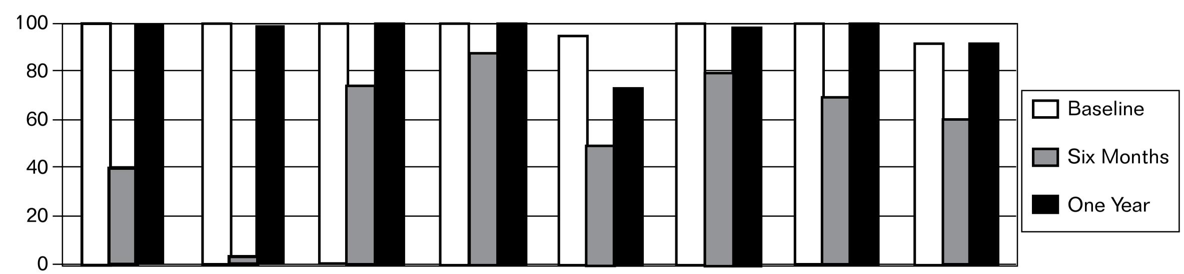
POST-TRAUMA OUTCOMES

- Outpatient rehab = 3x weekly for 16 weeks
- Return to school @ 1 month post-trauma
- Re-broke same leg after resuming activities too aggressively
- Due to fearfulness, patient did not return to driving until 8 months post-injury
- Unable to return to sports activities and is concerned about college recruitment prospects
- Doing very well @ 1 year, now a senior in high school, resumed fall sports and academic activities, working with a trainer to increase speed and coordination.

COST (CAPTURED CHARGES ONLY)

Hospital	$ 36,709
Professional	$ 6,400
Rehabilitation - OP	$ 6,240
Total	**$ 49,349**

SF-36



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