



Hospitalizations and Medical Care Costs of Serious Traumatic Brain Injuries, Spinal Cord Injuries and Traumatic Amputations

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Executive Summary	1
Introduction	3
Methods	5
Results	7
Medicaid Costs.....	9
Discussion	11
Limitations.....	11
Conclusions	13
References	15





This report describes the number of hospitalizations and costs of three types of injuries in the state of Arkansas: serious traumatic brain injuries (TBI), spinal cord injuries (SCI) and traumatic amputations of the limbs (TAL). Data for the report came from two sources: the hospital discharge database maintained by the Arkansas Department of Health and claims data from the Arkansas Medicaid program. Data covering the period 2005–2010 from ADH were used to ascertain cases of the three types of injuries in the state by insurance status. Data from individuals enrolled in the Arkansas Medicaid program during the period 2007–2012 were used to estimate the cost of acute care and post-acute care services. No attempt was made to link the two data sets. The main findings include:

- (1) Evidence that patients lacking health insurance have a lower probability of discharge to a facility for rehabilitation services
- (2) There is a high probability of readmission to an acute care hospital in the year following discharge for the initial hospitalization
- (3) Post-acute care costs differ by a factor of 3 to 4 for patients who are readmitted to the hospital following a rehabilitation stay

The data are limited and do not allow causal interpretations of the findings. The differences in post-acute care costs may result from differences in case mix and severity that cannot be accounted for in this analysis. Still, we believe the findings have utility for strategic planning. State agencies should consider the impact of health care reform on the provision of rehabilitation services. The number of uninsured persons with the injuries described in this report should decrease, which would lead to an increase in the number of patients who will receive post-acute care services. Functional outcome assessment appears warranted to understand the variations in services according to insurance status. Quality improvement efforts should be identified to assess whether readmissions to hospitals could be reduced, as such efforts have the potential to be cost saving.



This report describes three types of injuries in the state of Arkansas that result in hospitalization: serious traumatic brain injuries, spinal cord injuries and traumatic amputations. The specific focus of this report is to provide an estimate of the number of hospitalizations for these injuries in the state as well as the breakdown of acute and post-acute costs based on Arkansas Medicaid data. To accomplish the goals of this report, the authors used the Arkansas statewide hospital discharge data to describe the incidence of hospitalizations in the state for the three conditions and the percentage of hospitalized patients who were discharged to a facility (skilled nursing, rehabilitation, etc.). This analysis included a breakdown of patients by insurance status, including private payers, Medicaid and Medicare, and uninsured patients.

The authors also used Medicaid claims data to calculate acute care costs occurring during the initial hospitalization associated with the injury, the rehabilitation costs incurred in a facility following hospital discharge, and medical care costs in the year following hospital discharge. The authors did not attempt to link the two data sets.



Patients were identified in both administrative data sets using ICD-9 discharge diagnosis codes. The authors identified diagnosis codes for use in each condition by conducting a literature search of articles contained in PubMed. The literature search produced a number of studies that used administrative data to identify traumatic brain and spinal cord injuries. The authors did not find studies that identified traumatic amputations through administrative data. Based on the identified studies and expert opinion, the authors developed coding schemes for identifying people hospitalized for the three conditions. The specific coding schemes are described below.

CASE DEFINITION FOR TRAUMATIC BRAIN INJURIES:

800.0–801.9, 803.0–804.9, 850.0–854.1 and 959.01 with head abbreviated injury scores ≥ 3 for incidence estimates and admitted to a skilled nursing facility or rehabilitation facility for cost estimation

CASE DEFINITION FOR SPINAL CORD INJURIES:

806.x and 952.x (without evidence of spinal bone injury)

CASE DEFINITION FOR TRAUMATIC AMPUTATION OF THE LIMBS:

887.x (arm and hand), 896.x (foot) and 897.x (leg)

In both administrative data sets, the authors used primary and secondary diagnosis codes to identify hospitalizations. Failure to use both primary and secondary diagnosis codes would result in an undercount of total injury cases as some patients may have complications from their injuries that are then coded as the primary diagnosis code. Care also is needed to ensure that the hospitalization is the result of the initial injury and not complications of the injury, as patients with spinal cord injuries could be hospitalized after the initial injury for pneumonia (or any other complication) and have the spinal cord injury listed as a secondary diagnosis code. For this reason, the authors used evidence of an external cause of injury code to verify that the hospitalization occurred because of an injury. Finally, only hospitalized patients that survived the hospitalization were included in incidence estimates, as this report is concerned with planning rehabilitation needs.

Hospitalizations for brain injuries can range from mild to severe. To better assess need for rehabilitation services and the cost of services, the authors identified patients with traumatic brain injuries based on abbreviated injury scores. All patients with a diagnosis code consistent with our case definition above (CDC-defined brain injury) and an abbreviated injury score ≥ 3 were included in the incidence estimates. In our cost estimates of brain injuries, we restricted the analysis to hospitalized patients who were discharged to a facility.



Tables 1 through 3 provide hospitalization incidence estimates and the probability that hospitalized patients will be discharged from the hospital to a rehabilitation facility appropriate for each injury type. Over the period 2005–2010, a total of 8,172 people were hospitalized with a CDC-defined brain injury that recorded a head AIS score of ≥ 3 . The highest percentage of patients were insured in the Medicare program (41.3 percent). Notably, a large percentage of patients lacked health insurance during their hospitalization (15.6 percent).

TABLE 1. Hospitalizations for Traumatic Brain Injury and Percentage Discharged to Rehabilitation by Insurance Status, 2005–2010

SOURCE OF PAYMENT	HOSPITALIZED		DISCHARGED TO FACILITY	
	N	PERCENT	N	PERCENT*
CHAMPUS	41	0.5	4	9.8
Commercial Insurance	1,839	22.5	324	17.6
HMO/Managed Care	383	4.7	50	13.1
Medicaid	908	11.1	90	9.9
Medicare	3,373	41.3	667	19.8
Other	173	2.1	16	9.2
Self-Pay	1,272	15.6	123	9.7
Self-Insurance	64	0.8	10	15.6
Workers Comp	102	1.3	22	21.6
TOTAL**	8,172	100.0	1,307	16.0

** Percent of hospitalized. • **NOTE: May not add up as cells with small numbers were deleted*

The probability of being discharged to a facility also differed according to insurance status. Patients with workers' compensation or Medicare had the highest probability of being discharged to a facility (21.6 percent and 19.8 percent) while patients lacking health insurance had the lowest probability of discharge to a facility for rehabilitation (9.7 percent).

TABLE 2. Hospitalizations for Spinal Cord Injury and Percent Discharged to Rehabilitation by Insurance Status, 2005-2010

SOURCE OF PAYMENT	HOSPITALIZED		DISCHARGED TO FACILITY	
	N	PERCENT	N	PERCENT*
Commercial Insurance	324	27.3	126	38.9
HMO/Managed Care	76	6.4	27	35.5
Medicaid	152	12.8	55	36.2
Medicare	345	29.0	97	28.1
Other	25	2.1	5	20.0
Self-Pay	209	17.6	70	33.5
Self-Insurance	7	0.6	2	28.6
Workers Comp	38	3.2	16	42.1
TOTAL **	1,188	100.0	400	33.7

** Percent of hospitalized. • **NOTE: May not add up as cells with small numbers were deleted*

Similar to brain injuries, most of the hospitalized patients with spinal cord injuries were in the Medicare population (29.0 percent), followed by the commercially insured (27.3 percent) and people without health insurance (17.6 percent). In contrast to brain injuries, however, there is less variability in the probability that a patient is discharged to a facility. Patients with Medicare had the lowest probability of discharge to a facility at 28.1 percent, while commercially insured patients were at 38.9 percent. People without health insurance had a lower probability of discharge to a facility at 33.5 percent.

Traumatic limb amputations have a low incidence in Arkansas, with 98 people hospitalized over the six-year period. The highest percentage of traumatic limb amputations occurred with people who had commercial insurance (34.7 percent), followed by Medicare (17.3 percent) and uninsured people (16.3 percent).

Rates of discharge to facilities following hospitalization were higher for the commercially insured and Medicare insured, at 29.4 percent and 23.5 percent respectively. Rates for people lacking health insurance were lower, at 12.5 percent.

TABLE 3. Hospitalizations for Traumatic Limb Amputations and Percentage Discharged to Rehabilitation by Insurance Status, 2005-2010

SOURCE OF PAYMENT	HOSPITALIZED		DISCHARGED TO FACILITY	
	N	PERCENT	N	PERCENT*
Insured	82	83.7	18	22.0
Self-Pay	16	16.3	2	12.5
TOTAL **	98	100.0	20	20.4

** Percent of hospitalized. • **Including Medicaid.*

TABLE 4. Hospitalizations by Injury Type and Gender, 2005-2010

GENDER	N	PERCENT
Traumatic Brain Injury		
• Male	5,509	60.7
• Female	3,561	39.3
Spinal Cord Injury		
• Male	832	66.2
• Female	424	33.8
Traumatic Limb Amputation		
• Male	88	85.4
• Female	15	14.6

Table 4 provides hospitalizations by injury type and gender. In each of the injuries examined, males were significantly more likely to be hospitalized than females. For TBI, males accounted for 60.7 percent of hospitalizations, compared to 39.3 percent for females. For SCI, males accounted for 66.2 percent, compared to 33.8 percent for females. For TAL, males accounted for 85.4 percent, compared to 14.6 percent for females.

Medicaid Costs

Table 5 presents acute and post-acute care costs by diagnosis for Medicaid patients under the age of 65. Patients over the age of 64 were not included because they are eligible for Medicare and thus a large portion of the costs of care are not captured in the Medicaid system. Including these costs in the analysis would bias the estimated costs towards zero. The data in Table 5 indicate that the mean post-acute care costs exceeded acute care costs by 44 percent for TBI patients, 64 percent for SCI patients and 25 percent for TAL.

TABLE 5. Acute and Post-Acute Care Costs by Diagnosis, 2007-2012

DIAGNOSIS	TOTAL ACUTE CARE COSTS	MEAN ACUTE CARE COSTS	TOTAL POST-ACUTE CARE COSTS	MEAN POST-ACUTE CARE COSTS	RATIO PA TO A
TBI	\$3,440,753	\$15,783	\$4,904,932	\$22,708	1.44
SCI	\$2,696,486	\$18,343	\$4,297,583	\$30,053	1.64
TAL	\$276,077	\$19,720	\$344,838	\$24,631	1.25
TOTALS	\$6,413,316	\$16,922	\$9,547,354	\$25,596	1.51

Patients <65 years of age.

The cost estimates in Table 5 can be used for planning expenditures or cost-benefit analyses of prevention interventions. For example, if a case of spinal cord injury could be prevented, the cost savings per case for the initial year would be approximately \$18,343 in acute care costs and \$30,053 in post-acute care costs. Because the data are based on Medicaid payments, the reported estimates better reflect the costs to the health care system compared to private insurance payments or Medicare payments.

TABLE 6. Patient Readmission Status and Post-Acute Care Costs by Diagnosis, 2007-2012

DIAGNOSIS	READMITTED			NOT READMITTED			READMISSION PERCENT
	N	TOTAL POST-ACUTE CARE COSTS	MEAN POST-ACUTE CARE COSTS	N	TOTAL POST-ACUTE CARE COSTS	MEAN POST-ACUTE CARE COSTS	
TBI	97	\$3,608,992	\$37,206	121	\$1,295,940	\$10,890	44.5%
SCI	79	\$3,759,357	\$47,587	68	\$538,225	\$8,410	53.7%
TAL	5	\$289,709	\$57,942	9	\$55,129	\$6,126	35.7%
TOTALS	181	\$7,658,059	\$42,310	198	\$1,889,295	\$9,840	47.8%

Patients <65 years of age.

Table 6 provides data on hospital readmission status and post-acute care costs for patients with the three different diagnoses. People hospitalized with these conditions face a high probability of readmission to an acute care hospital in the year following discharge from the initial hospitalization. People with a TBI diagnosis who were discharged from the initial hospitalization to a rehabilitation facility were subsequently readmitted to an acute care hospital 44.5 percent of the time in the first year following the initial discharge. Patients who were readmitted incurred substantially higher post-acute care costs in the year following discharge. For TBI patients who were readmitted to an acute care hospital, mean post-acute care costs were \$37,206, compared to \$10,890 for patients who were not readmitted.

The probability of readmission to a hospital was higher in SCI patients compared to TBI patients. SCI patients were readmitted to an acute care hospital in 53.7 percent of the cases. SCI patients who were readmitted had post-acute care costs of \$47,587, compared with \$8,410 for SCI patients who were not admitted.

The data presented in this report provide a snapshot of the incidence and cost of three types of injuries in the state of Arkansas. The information has use for planning rehabilitation services under changing reimbursement systems. For example, data from this report can be used to estimate the additional post-acute care costs of newly insured persons following insurance expansion. Based on the number of patients lacking health insurance (self-pay) from Tables 1 and 2, it is possible that 20 people per year who suffer a TBI now will be newly insured and an additional 10 people who suffer an SCI will be newly insured compared to previous years. These newly insured persons are likely to have access to more post-acute services. We estimate that the additional post-acute care costs incurred by newly insured TBI patients of high severity will be around \$500,000 per year.

Limitations

The data used in this report have a number of limitations. We cannot predict the impact of quality improvement efforts on the probability of readmission to an acute care hospital or post-acute care costs following the initial discharge. Larger samples from multiple states will be needed, along with quasi-experimental methods of analysis, to address this question. The authors were unable to generate a wide range of severity and case mix measures to address confounding. For this reason, it is not possible to infer how much could be saved by preventing readmission to a hospital following discharge from rehabilitation. Finally, the data come from a single state and limit the sample size for analysis despite the use of six years of claims data. Nonetheless, the data presented in this report point to a need for a strategic plan to assess rehabilitation needs associated with these three types of injuries.



The findings in this report highlight areas to consider for prevention and quality improvement efforts with respect to rehabilitation services associated with serious TBI, SCI and TAL. First, serious TBI occurs more frequently in the Medicare population, and increased prevention efforts should be directed at this population. There also is a significant incidence of injuries for people lacking health insurance. Health care reforms could increase the availability of services to the currently uninsured and raise the costs of providing post-acute care services in the state. The cost of increased services for serious TBI is likely to be less than \$1 million per year because we anticipate some amount of services to be provided to the uninsured despite their lack of insurance. Because there is variation in the amount of services provided to people with serious injuries, we recommend a system of functional outcome assessment to better understand the impact of these variations and design programs to ensure optimal outcomes.

This report also documents that there is a high probability that people with these three types of injuries will be readmitted to an acute care hospital following discharge from rehabilitation. Understanding the factors associated with readmission to acute care hospitals could guide quality improvement efforts. Quality improvement efforts that can reduce readmissions may be cost saving given the difference in costs between patients who are readmitted and those who are not. While a large portion of the difference is likely to be related to differences in severity and case mix, it is also possible that quality improvement efforts can reduce readmissions and reduce costs. Further work in this area appears warranted.





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