Spinal Injury Hospitalizations Among U.S. Army Soldiers Deployed to Iraq and Afghanistan

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ABSTRACT This retrospective study examined spinal-related hospitalizations of U.S. Army soldiers deployed to Afghanistan and Iraq. Spinal cord injuries (SCI) and vertebral column injuries (VCI) were identified using International Classification of Disease, 9th Revision, Clinical Modification diagnosis codes. In our study, spinal hospitalizations represented 8.2% of total injury admissions. Risk factors for SCI and VCI incidences were determined using Poisson regression. Lack of previous deployment experience increased risk of having SCI by 33% and VCI by 24% in Iraq (similar increases, but not statistically significant in Afghanistan). Male soldiers had 4.85 times higher risk for SCI in Iraq and 69% higher risk in Afghanistan than female soldiers. In Afghanistan, almost 60% of spinal episodes included traumatic brain injury (TBI), compared to about 40% in Iraq. In both theaters, mild TBI accounted for more than 50% of all TBI-spinal episodes. Sixteen percent of SCI inpatient episodes in Afghanistan and 13% in Iraq were associated with paralysis, with median bed days of 46 and 33 days compared to a median of 6 days in both theaters for nonparalysis spinal injuries. The mortality rate was 2.5 times lower in Afghanistan than in Iraq.

INTRODUCTION

The pattern of war injuries in present conflicts is different from that encountered in previous wars. U.S. forces deployed to Afghanistan and Iraq have mainly been involved in operations where enemy tactics are primarily based on insurgency.[1–3] As a result, explosive mechanisms, typically improvised explosive devices, are the most common cause of injuries and death among service members in Iraq and Afghanistan.[2–7] These explosive devices account for 67% of hostile casualties (both wounded and killed) in Iraq and 61% in Afghanistan.[8] Blast injuries often result in polytrauma (multiple types of injuries and/or injuries to multiple body regions) with some examples being traumatic brain injury (TBI), ear and eye injuries, spinal cord injury (SCI), extremity injuries, amputations, burns, open wounds, compressible or noncompressible hemorrhage, and fractures.[2,6,7,9–11] Improvement of personal protective equipment (such as helmets and vests), enhanced vehicle armor, decreased medical evacuation time, and more sophisticated medical care are among factors that have substantially increased survival in recent conflicts compared to earlier wars. For example, the case fatality rate is 8.8% for Afghanistan and Iraq compared to 16.5% for the Vietnam War and 22.8% for World War II.[12–14] In many circumstances, service members today are surviving more severe injuries than in previous conflicts.[2,4,13,15]

Spinal injuries were a relatively low percentage (roughly 1%) of all combat injuries in most 20th century conflicts.[16] However, recent articles focusing on spinal injuries among U.S. military deployed to Iraq and Afghanistan have reported much higher spinal incidence rates.[17–21] In addition, spinal injuries and possible accompanying paralysis are frequently part of complex cases of polytrauma.[11,16,19,22,23] For example, several studies have concluded that TBI commonly occurs with traumatic spinal injury[22–26] and its presence can complicate rehabilitation.[19,24,25] With the rise in spinal injury occurrence and the increased survival from more severe spinal injuries with polytrauma, there is a greater need for better understanding of this problem affecting U.S. military service members.[7,27–30]

Although several articles have focused on spinal injuries among military personnel, they were restricted to one theater, to specific military units or treatment facilities, to the first few years of the conflicts, or they applied only to American service members who were medically evacuated from theater.[17–20,27] In contrast, our study compared spinal injury hospitalizations sustained by U.S. Army soldiers from the beginning of current conflicts in Afghanistan and Iraq through the end of January 2011, and included both those treated only in theater plus those treated in theater and then medically evacuated.

This manuscript was derived from analyses performed by the Center for Army Medical Department Strategic Studies (CASS) in response to a series of inquiries to support operational readiness. Its main focus is to compare spinal-related hospitalizations between two theaters: Iraq and Afghanistan. To better perceive injury characteristics, we looked at SCIs, vertebral column injuries (VCI), and all spinal injuries combined. Separate analyses were performed for spinal injuries sustained in Afghanistan and Iraq to identify similarities and differences in spinal injury profiles of the two theaters. In addition, we examined presence of paralysis and TBI in

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doi: 10.7205/MILMED-D-14-000061

inpatient spinal incidences among soldiers deployed to Iraq and Afghanistan.

METHODS

Data for this retrospective study were obtained from three military databases. Population data for U.S. Army soldiers deployed to Afghanistan (from September 11, 2001) and Iraq (from September 1, 2002) through the end of January 2011 were provided by the Defense Manpower Data Center (DMDC). The population data consisted of demographics and deployment information, including deployment dates (both theater arrival and departure). Hospitalization data for soldiers were obtained from the Standard Inpatient Data Record (SIDR) database maintained by the U.S. Army Patient Administration Systems and Biostatistics Activity (PASBA). SIDRs are the Department of Defense (DoD) official administrative records of hospitalization in military treatment facilities (MTFs) worldwide. Additional data on circumstances of the incident, such as cause of injury, were obtained from the Defense Casualty Information Processing System (DCIPS) maintained by the Army's Casualty and Memorial Affairs Operations Center.

SIDRs were matched to DMDC deployment records to identify admissions that occurred during soldier deployments to Afghanistan and Iraq. We examined admissions at Army MTFs in theater, and for soldiers medically evacuated, also in Europe and the United States. Spinal admissions (SCI and VCI) and admissions with possible comorbid paralysis and TBI were identified by searching all recorded diagnoses (up to 20 per SIDR) for specified International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes (Table I). Guidance on selection of ICD-9-CM codes was received from the Armed Forces Health Surveillance Center.

To avoid multiple counting of the same spinal injury incident for soldiers being moved from one MTF to another for continuum of care, episodes of care were created. Each episode had to have at least one spinal diagnosis. Admissions within an episode had to occur within the same deployment. Patients could have more than one episode of care (i.e., if they were admitted with a spinal injury, returned to duty, and had another spinal injury).

Patient demographics data were obtained from each soldier's first spinal admission in theater. The proportion of deployment admissions with spinal diagnoses was calculated as a percentage of total deployment admissions. All other analyses and results were based on episode-level data. Each spinal episode was assigned to one of two spinal categories: SCI if an SCI diagnosis was present in any admission of the episode and VCI otherwise. Presence of a paralysis diagnosis in any episode admission classified the entire episode as flagged for paralysis; similarly, any TBI diagnosis classified the entire episode as flagged for TBI. In addition, TBI diagnoses were assigned to severity categories according to the TBI surveillance classification established by a DoD working group led by the Defense and Veterans Brain Injury Center. An episode was assigned the most severe TBI category present in any of its admissions. Bed days for the episode were the sum of bed days across all admissions for the entire episode.

Multiple Poisson regression was used to estimate the relative risk of having an inpatient spinal episode during deployment for each of the two spinal categories (SCI, VCI) while simultaneously adjusting for potential military and demographic risk factors. On the basis of our previous studies, the following independent variables were included in our analysis: gender (male, female), age at time of deployment (<20, 20–29, 30–39, 40–49, 50+), component (active duty, National Guard, reserve), grade (enlisted, officer), unit (combat, combat support, combat service support), and deployment (previously deployed to Iraq or Afghanistan, first deployment in Iraq or Afghanistan). We defined the reference

TABLE I. Classification of ICD-9-CM Diagnosis Codes into Study Categories

Study Category	ICD-9-CM Diagnosis Codes
Spinal-Related Injury	
Spinal Cord Injury	806.xx, 952.xx
Vertebral Column Injury	805.xx, 839(.0x–.5x), 847(.0–.4)
Paralysis	344.xx, 438.5x, 780.72
Traumatic Brain Injury [a]	
Penetrating	(800, 801, 803, 804)(.6–.9), 851(.1, .3, .5, .7, .9), 852(.1, .3, .5), (853, 854)(.1), (V15.5, V15.52, V15.59)(_5, _A, _F)
Severe	[800, 801, 803, 804](.04–.05, .14–.15, .24–.25, .34–.35, .44–.45, .54–.55), 850(.3–.4), 851(.04–.05. .24–.25, .44–.45, .64–.65, .84–.85), 852(.04–.05, .24–.25, .44–.45), [853,854](.04–.05), [V15.5, V15.52, V15.59](_4, _9,_E)
Moderate	[800, 801, 803, 804](.03, .10–.13, .16, .19, .20–.23, .26, .29, .30–.33, .36, .39, .40–.43, .46, .49, .53, .56, .59), 850(.12, .2), 851(.00–.03, .06, .09, .20–.23, .26, .29, .4, .40–.43, .46, .49, .6, .60–.63, .66, .69, .8, .80–.83, .86, .89), 852(.00–.03, .06, .09, .2, .20–.23, .26, .29, .4, .40–.43, .46, .49), [853, 854](.00–.03, .06, .09), [V15.5, V15.52, V15.59](_3, _8, _D)
Mild	310.2, [800, 801, 803, 804](.00–.02, .06, .09, .50–.52), 850(.0, .1, .11, .5, .9), 959.01, [V15.5, V15.52, V15.59] (_2, _7, _C)
Unclassified	907.0, 950(.1, .2, .3), [V15.5, V15.52, V15.59](_0, _1, _6, _B)

[a]DoD TBI surveillance classification established by DoD working group led by the Defense and Veterans Brain Injury Center.

categories as female, age between 20 and 29 years, active duty, officer, combat unit, and previously deployed to Iraq or Afghanistan.

Data used by CASS were obtained and analyzed following strict data governance rules approved by the Army Human Research Protection Office (AHRPO): records were limited in scope to variables needed for the stated purposes and deidentified. All personally identifiable information was removed to protect soldier identity and prevent rematch of protected health information data back to individual patients. AHRPO deemed CASS analyses do not constitute human subject research in accordance with the Common Rule definition. All datasets were protected on secure DoD servers. All data analyses were performed using SAS version 9.1.3 software. All *p*-values less than 0.05 were considered statistically significant.

RESULTS

Out of a total of 35,084 injury admissions to U.S. Army MTFs by soldiers during deployments to Afghanistan and Iraq, there were 2,910 admissions with at least one SCI or VCI diagnosis. On the basis of these admissions (which involved 1,711 soldiers), 1,713 spinal episodes were created (two soldiers had two separate episodes of care, with one of the soldiers having an episode in each theater).

Demographic characteristics of the U.S. Army soldiers who sustained spinal injuries in Afghanistan and Iraq are presented in Table II. In both theaters, more than 95% of the soldiers with spinal admissions were males and the majority were 20 to 29 years of age (Afghanistan: 70%, Iraq: 63%). More than two-thirds (n = 1,188) of spinal episodes occurred in Iraq; 525 spinal episodes were in Afghanistan. VCI represented the majority of episodes in both theaters, but accounted for a higher percentage in Afghanistan (84% compared to 79% in Iraq) (Fig. 1).

The number of admissions per episode of care and number of bed days per any spinal episode had comparable summary statistics in Afghanistan and Iraq (Table III). However, for SCI episodes, the median number of bed days was 29.0 in Afghanistan and 20.0 in Iraq, and for VCI episodes was 6.0 in Afghanistan and 5.0 in Iraq.

Overall, soldiers who had a recorded spinal injury had a higher survival rate in Afghanistan than Iraq (98.7% vs. 96.7%) (Table IV), and similar relationships were found for SCI and VCI. In addition, survival was higher for soldiers with VCI episodes compared to those with SCI episodes within each theater. Summarized by grade group, all mortalities of soldiers with spinal episodes in Afghanistan were found to be enlisted soldiers; however, in Iraq, 10% of mortalities of soldiers with spinal episodes were among officers.

Noting a higher mortality rate in Iraq relative to Afghanistan, we investigated polytrauma and TBI as possible contributing factors in the 46 spinal episodes resulting in soldiers' deaths. The Barell Injury Diagnosis Matrix[31] was used to obtain body region and nature of injury summaries of all injury diagnoses from the spinal episodes. On the basis of all spinal episodes, Afghanistan had approximately 8% more polytrauma cases (two or more body regions) than Iraq. A similar result was found when looking only at deceased soldiers: 100% in Afghanistan had polytrauma compared to 94.9% in Iraq.

TABLE II. Demographics of U.S. Army Soldiers Who Were Admitted With Spinal Injuries in Afghanistan and Iraq

	Afghanistan (n = 525)		Iraq (n = 1,187)	
Characteristic	n	(%)	n	(%)
Gender				
Male	508	(96.8)	1,130	(95.2)
Female	17	(3.2)	57	(4.8)
Age Group (Years)				
<20	33	(6.3)	95	(8.0)
20–29	366	(69.7)	742	(62.5)
30–39	99	(18.9)	273	(23.0)
40–49	25	(4.7)	62	(5.2)
50+	2	(0.4)	13	(1.1)
Unknown	0	(0.0)	2	(0.2)
Component				
Active Duty	425	(80.9)	896	(75.5)
National Guard	78	(14.9)	212	(17.9)
Reserve	22	(4.2)	79	(6.6)
Unit Category				
Combat	343	(65.3)	754	(63.5)
Combat Support	106	(20.2)	202	(17.0)
Combat Service Support	43	(8.2)	185	(15.6)
Medical	1	(0.2)	15	(1.3)
Unknown	32	(6.1)	31	(2.6)
Grade Group				
Enlisted	480	(91.4)	1,106	(93.2)
Officer	45	(8.6)	78	(6.6)
Unknown	0	(0.0)	3	(0.2)

There were 1,711 soldiers that experienced spinal episodes during deployment. One of the soldiers accounted for demographics in both Iraq and Afghanistan since he had two spinal episodes, 1 during deployment to Iraq and one during deployment to Afghanistan. Therefore, numbers in the table add to 1,712.

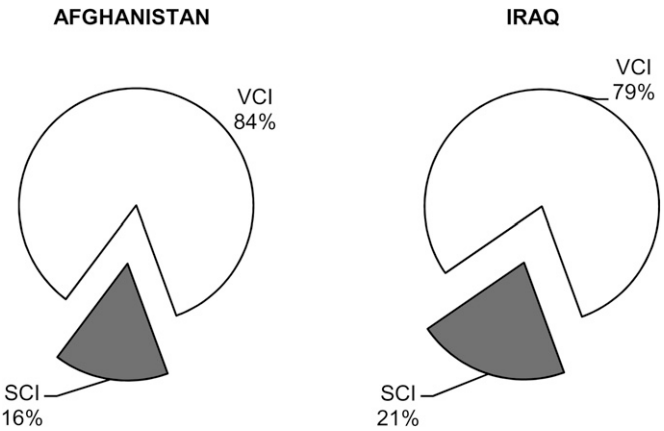

FIGURE 1. Distribution of spinal injury type (SCI, VCI) within theater (Afghanistan, Iraq) among U.S. Army soldiers. There is a statistically significant relationship between spinal injury type and theater: $\chi^2 = 6.1806$, $df = 1$, $p = 0.013$.

TABLE III. Summary Statistics of Inpatient Spinal Episodes for U.S. Army Soldiers Deployed in Iraq and Afghanistan

Characteristic	Afghanistan (n = 525)			Iraq (n = 1,188)		
	Mean	SD	Median	Mean	SD	Median
Number of Admissions Per Episode[a]	1.9	0.97	2.0	1.8	0.91	2.0
Number of Bed Days Per Episode[b]	19.7	31.62	7.0	19.3	36.59	7.0

[a]Mean number of admissions per episode did not differ significantly between Afghanistan and Iraq: $t = 1.81$, $df = 1{,}711$, $p = 0.071$. [b]Mean number of bed days per episode did not differ significantly between Afghanistan and Iraq: $t = 0.26$, $df = 1{,}150$, $p = 0.795$.

However, in summarizing the nature of injury in mortality episodes, we found more internal organ and open wound injuries in Iraq and more amputations and burns in Afghanistan. Among deceased soldiers with spinal injuries, over 12% more soldiers in Iraq had TBI compared to those in Afghanistan.

The risk of having an SCI inpatient episode and the risk of a VCI episode are presented by theater (Table V). In Iraq, soldiers on their first deployment had 33% higher risk for SCI. Lack of previous deployment showed 40% increased risk (nonsignificant) in Afghanistan. Male soldiers were at 4.85 higher risk for SCI injuries than female soldiers in Iraq and 53% higher risk in Afghanistan, but this risk was not statistically significant. In Iraq, soldiers on their first deployment had higher risk (24%) for VCI than soldiers with previous deployment experience, that risk was 15% higher (nonsignificant) in Afghanistan. Male soldiers had 69% higher risk for a VCI episode than female soldiers in Iraq and 2.54 times higher risk in Afghanistan.

We found that 2.7% of all spinal episodes in Afghanistan and 3.0% in Iraq had paralysis diagnoses (Fig. 2). Percentages of VCI episodes with paralysis were less than 1% in both theaters. In contrast, paralysis accompanied 16% of SCI episodes in Afghanistan and 13% of SCI episodes in Iraq. In Afghanistan, spinal episodes with paralysis diagnoses had longer median bed days than in Iraq (46 days vs. 33). Median number of bed days for spinal episodes with no paralysis was 6 days in both theaters.

Nearly 58% of all spinal episodes in Afghanistan contained TBI diagnoses compared to 36% in Iraq (Fig. 2). In both theaters, mild TBI (mTBI) accounted for 50% or more of all TBI-spinal episodes, followed by moderate TBI. Iraq had almost twice the percentages of penetrating and severe TBI–spinal cases than Afghanistan.

None of the soldiers who had a spinal injury with a mTBI died during the spinal episode and 67% of soldiers with mTBI returned to duty from the final admission of their spinal episodes. In mTBI–SCI episodes, most of the last admissions were at MTFs in Germany and the United States (32% and 59%). However, in VCI episodes with mTBI, the last MTF where the patient was treated was more widely distributed across Roles 3, 4, and 5 (43%, 26%, and 30%, respectively). In 70% of VCI episodes with mTBI, spinal and brain injuries were documented on the same admission. However, in SCI episodes with mTBI, spinal and brain injuries were documented on the same admission less than half of the time.

Among all spinal episodes, 1.5% had both paralysis and TBI (in both Afghanistan and Iraq). Most of the paralysis cases (in both theaters) were found among soldiers who experienced SCI. For VCI cases, paralysis was very rare. In Afghanistan, there was only one VCI episode that had both paralysis and TBI. In Iraq, there were only three documented VCI episodes with paralysis, none of these had TBI.

From casualty incident records, cause of injury was identified for 367 (70%) spinal episodes in Afghanistan and 782 (66%) episodes in Iraq. The majority of these inpatient spinal episodes in both theaters were the result of explosive devices, primarily improvised explosive devices, followed by transport accidents, gunshot wounds (GSWs), and falls (Fig. 3).

There were similar profiles for cause of injury for SCI episodes in Iraq and Afghanistan with explosive devices being the number one reason for SCI. In Afghanistan, explosive devices accounted for over 70% of VCI episodes, whereas in Iraq, they accounted for about 50%. There was a higher percentage of VCI as a result of transport accidents and falls in Iraq than in Afghanistan.

DISCUSSION

Increase in spinal injuries among U.S. military serving in Afghanistan and Iraq compared to previous conflicts is drawing more attention to this serious and life-affecting problem which can negatively impact soldiers' lives.[11,16] It has been noted that soldiers returning from Iraq and Afghanistan who

TABLE IV. Mortality Percentages for U.S. Army Soldiers Who Were Admitted With Spinal Injuries in Iraq and Afghanistan

Spinal Injury Type	Afghanistan		Iraq	
	Total Number of Episodes	Mortality (%)	Total Number of Episodes	Mortality (%)
All Spinal Injuries	525	(1.3)	1,188	(3.3)
SCI	83	(3.6)	249	(7.2)
VCI[a]	442	(0.9)	939	(2.2)

SCI, spinal cord injury; VCI, vertebral column injury. [a]VCI without presence of SCI.

TABLE V. Result of Poisson Regression of SCI and VCI Inpatient Episodes in Iraq and Afghanistan

	Iraq						Afghanistan					
	SCI (N = 249)			VCI[a] (N = 939)			SCI (N = 83)			VCI[a] (N = 442)		
Group	RR	p*	95% CI	RR	p*	95% CI	RR	p*	95% CI	RR	p*	95% CI
Gender												
Female	1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)	
Male	**4.85**	**0.002**	**1.79–13.09**	**1.69**	**<0.001**	**1.25–2.28**	1.53	0.413	0.55–4.23	**2.54**	**0.001**	**1.46–4.44**
Age Group												
20–29	1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)	
<20	0.86	0.561	0.53–1.41	1.17	0.203	0.92–1.49	0.86	0.749	0.34–2.18	0.82	0.334	0.56–1.22
30–39	**0.63**	**0.010**	**0.45–0.90**	1.06	0.454	0.91–1.24	1.08	0.761	0.64–1.83	**0.63**	**<0.001**	**0.49–0.81**
40–49	0.61	0.105	0.34–1.11	**0.62**	**0.003**	**0.45–0.85**	0.74	0.539	0.28–1.94	**0.46**	**0.001**	**0.29–0.74**
50+[b]	1.22	0.713	0.43–3.45	0.59	0.174	0.28–1.26				0.26	0.062	0.06–1.07
Component												
Active Duty	1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)	
National Guard	**0.42**	**<0.001**	**0.28–0.64**	0.86	0.086	0.73–1.02	0.62	0.141	0.33–1.17	**0.70**	**0.009**	**0.53–0.91**
Reserve	0.66	0.155	0.37–1.17	0.81	0.129	0.61–1.06	0.33	0.135	0.08–1.41	0.83	0.407	0.54–1.28
Grade												
Officer	1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)	
Enlisted	**1.74**	**0.024**	**1.08–2.80**	**2.46**	**<0.001**	**1.84–3.28**	1.37	0.379	0.68–2.76	**1.97**	**<0.001**	**1.37–2.82**
Unit												
Combat	1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)	
Combat Support	**0.65**	**0.016**	**0.45–0.92**	**0.77**	**0.004**	**0.65–0.92**	0.94	0.839	0.53–1.67	0.98	0.886	0.77–1.25
Combat Service Support	**0.27**	**<0.001**	**0.18–0.43**	**0.49**	**<0.001**	**0.41–0.59**	0.51	0.070	0.25–1.05	**0.39**	**<0.001**	**0.28–0.56**
Previously Deployed												
Yes	1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)		1.00	(Baseline)	
No	**1.33**	**0.041**	**1.01–1.64**	**1.24**	**0.004**	**1.07–1.43**	1.40	0.164	0.87–2.26	1.15	0.168	0.94–1.41

SCI, spinal cord injury; VCI, vertebral column Injury. [a]VCI without the presence of SCI. [b]Soldiers in age group 50+ were removed from the model for SCI risk in Afghanistan in order for the maximum likelihood algorithm to converge. *The values presented in boldface indicate statistically significant risk ratio (RR) at 0.05 significance level ($p < 0.05$).

experienced polytrauma are at greater risk for post-traumatic stress disorder than uninjured soldiers who experienced the same combat events.[9,11,32] Profiling spinal injuries in each theater, our article provides information not previously reported about spinal injuries sustained by U.S. Army soldiers in Afghanistan and Iraq.

Several recent articles have reported a wide spectrum of spinal incident rates.[17–21] We found that hospitalizations which included spinal diagnoses represented 8.2% of total injury admissions. In our study, admissions with spinal diagnoses represented 6.6% of all battle injury admissions and 9.7% of nonbattle injury hospitalizations. Although we looked at all deployment admissions in both theaters, our percentages are comparable to those reported in other articles, which were based on a subset of the entire deployed population at risk, such as only soldiers who were injured in one theater, or medically evacuated, or treated at a particular MTF, or were members of a specific unit.[17–21] Our findings on cause of injury were consistent with previous reports on combat injuries in Afghanistan and Iraq.[2,4,19] We found that most spinal injuries were caused by explosive devices and that GSWs were more prevalent in SCI than in VCI episodes.

The majority of spinal injuries in Afghanistan and Iraq were VCI, without presence of SCI. Looking at the other injury type, some SCI episodes did not have recorded VCI diagnosis. The absence of a VCI diagnosis with SCI injury is not a typical scenario in adult patients. One limitation of our study is that it is based on administrative secondary data; we were unable to follow with chart review of each medical record. These days, in both military and civilian settings, epidemiological and surveillance studies mostly use administrative databases. For the purpose of our project, three military administrative databases were utilized; all of which are widely used in military healthcare and deployment analysis. The SIDR database that was utilized to retrieve the information about the spinal-related hospitalizations of soldiers deployed to Iraq or Afghanistan is commonly used by Army leadership for broad military epidemiological and surveillance analyses. Any new information is subjected to numerous edits before being added into the SIDR database. However, as with any administrative database, there are usually some limitations in the data collection/recording process, which may be because of insufficient data standardization or instruction guidance. A possible explanation for the lack of VCI diagnoses on some of the SCI episodes is that the focus was on more severe and life-threatening injuries (i.e., polytrauma). Our examination of SCI episodes without VCI diagnosis revealed that the majority of other diagnoses recorded in these cases corresponded to open wounds and internal organ injuries. That fact seems to agree with our hypothesis that medical personnel dealing with polytrauma cases focus on the most severe diagnoses and may omit some

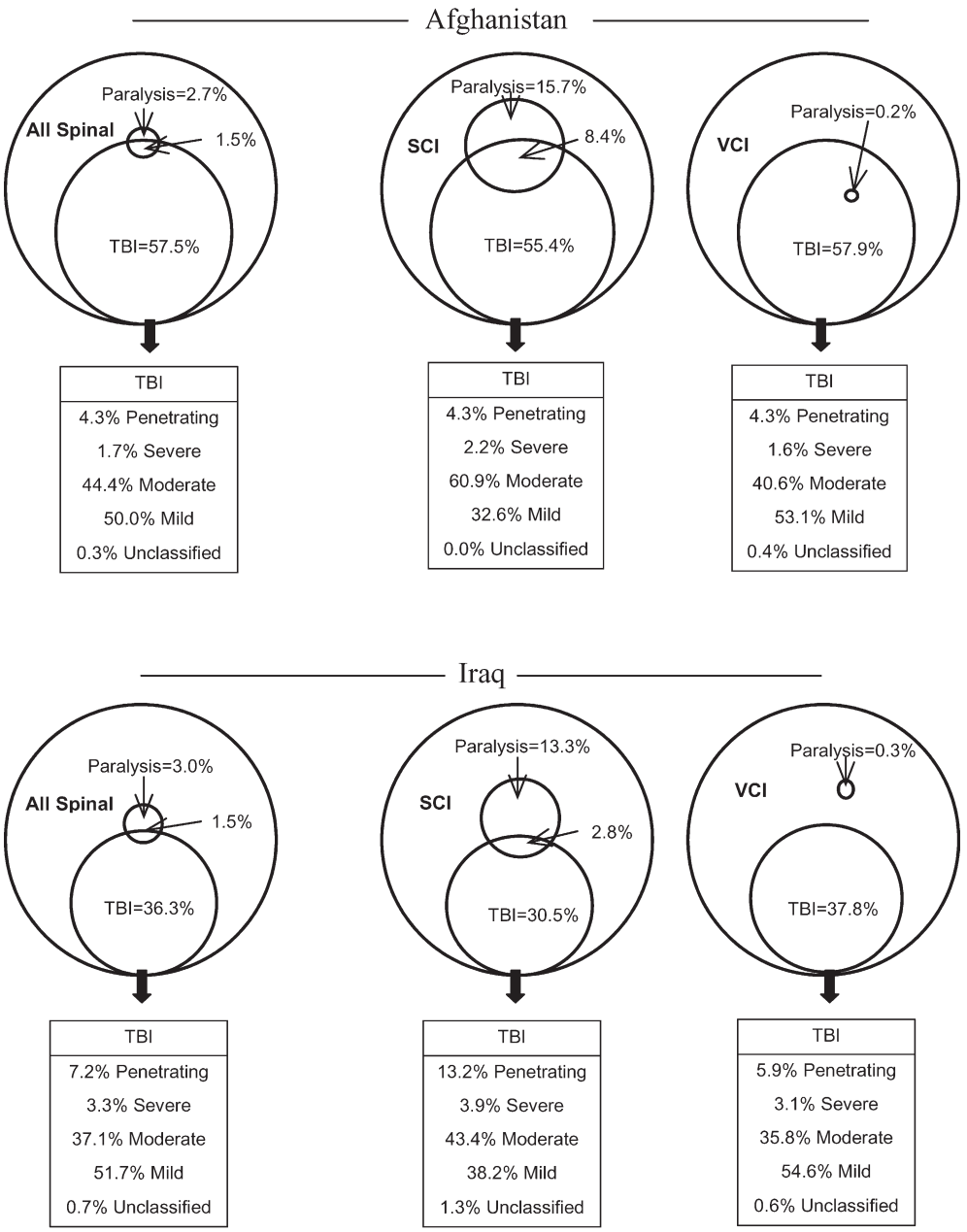

FIGURE 2. Presence of paralysis and TBI in inpatient spinal episodes of deployed U.S. Army soldiers in Afghanistan and Iraq.

obvious associated diagnoses. Perhaps in admissions at Role 3, these omissions may be partly because of the rapidity with which many severely injured patients are strategically evacuated from theater (i.e., they have been surgically stabilized, but have not undergone a comprehensive diagnostic evaluation). However, we found that many of the last admissions in our SCI episodes were at Roles 4 (Germany) or 5 (the United States). All the above indicate that VCI diagnoses are systematically missing from the medical records for cases with SCI and this practice is not limited only to records from theater. Our recommendation would be to explore causes for VCI diagnosis omission when SCI injuries are identified. A remedy could be to provide better guidelines for proper data gathering and recording. We hope our findings will help improve the policy on the capture of spinal diagnoses in medical records.

One of the findings from the risk analysis we conducted was that soldiers who did not have a previous deployment were at higher risk for both SCI (33%) and VCI (24%) episodes in Iraq, and although not statistically significant, there were similar increased risks (40% and 15%) in Afghanistan. However, there were only 83 cases of SCI in Afghanistan—with such a small number of observations, the power of detecting statistically significant risks is low.

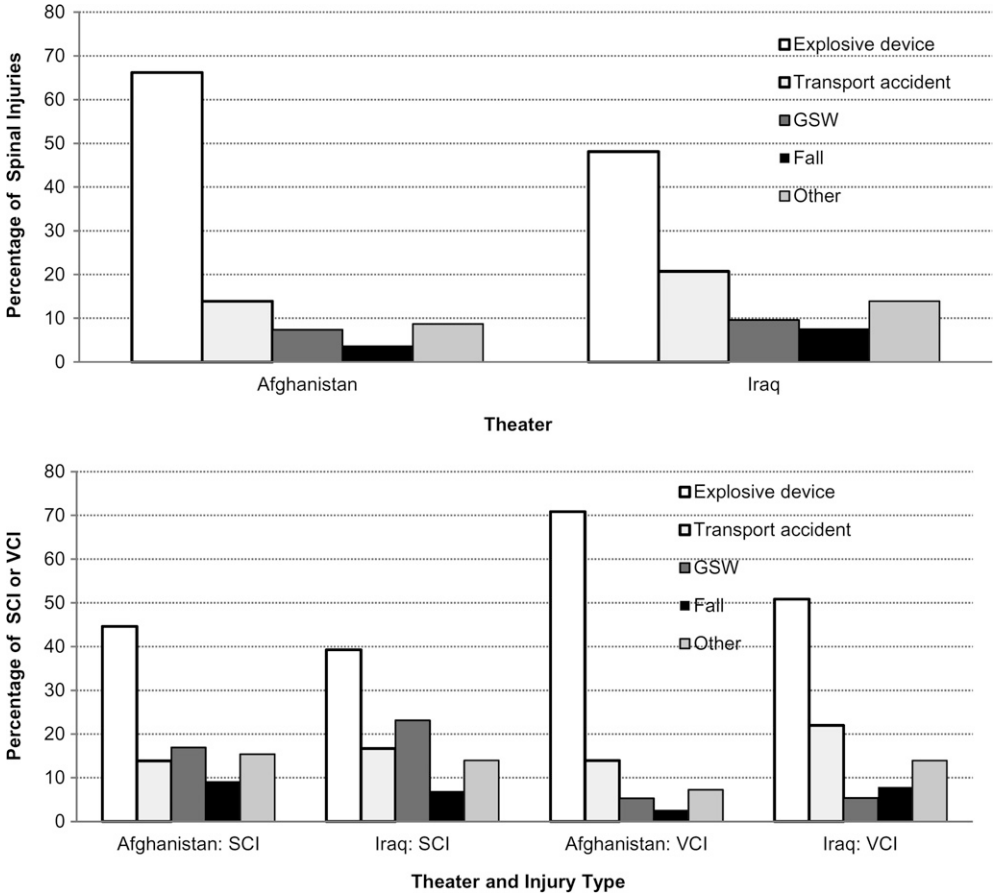

FIGURE 3. Injury cause by theater and type of spinal injury for U.S. Army Soldiers serving in Afghanistan and Iraq.

SCI mortality rates decreased during the 20th century. It was reported that during World War I, the SCI mortality rate was approximately 80%.[33,34] A significant decrease was observed in World War II with estimated rates between 7.4% and 14.5%.[35] In the Vietnam War, SCI accounted for 0.9% of admissions to U.S. Army hospitals, and out of those, 3.8% of patients died during hospitalization.[24,36] Our analysis found similar mortality rates for soldiers with SCI episodes in Afghanistan (3.6%), but higher mortality in Iraq (7.2%). Mortality rates for soldiers with VCI episodes were much lower (Afghanistan: 0.9%, Iraq: 2.2%). The higher mortality rate in Iraq led us to investigate polytrauma and TBI as possible contributing factors. We found that spinal episodes had more internal organ injuries and open wounds in Iraq than in Afghanistan.

This study was designed as a retrospective analysis of spinal injuries in both Iraq and Afghanistan. Only spinal-related hospitalizations of deployed U.S. Army soldiers were examined because the original request was in support of Army operational readiness and the interest was to optimize health care capabilities and capacities along the continuum of care. It is possible that other military services could have different mortality rates of service members with spinal episodes and different profiles of spinal injuries.

We found that VCI-only episodes were more common in both theaters (Afghanistan: 442, Iraq: 939) than SCI episodes (Afghanistan: 83, Iraq: 249). The pattern of spinal diagnoses was the same in both theaters with VCI being the largest group. However, our comprehensive analysis found that spinal injuries have different profiles in Afghanistan and Iraq, including different percentage of TBI comorbidity, TBI severity, cause of injury profiles, and mortality rates of soldiers with spinal episodes. Although SCI and VCI admission rates were higher in Afghanistan than Iraq, a higher percentage of soldiers survived spinal injuries in Afghanistan than in Iraq. It should also be noted that soldiers with spinal injuries in Afghanistan had a higher percentage of TBI comorbidity than spinal-injured soldiers in Iraq.

Our study provides comparison analysis of U.S. Army cord injured and noncord injured spinal trauma casualties between Iraq and Afghanistan. By identifying patterns of injury in both theaters, some doctrinal decisions regarding manpower (such as how many spine injury surgeons we may need in theater) and types of body armor protection (changes in armor, personal protective equipment, and so on) can be made. Additional studies might evaluate effectiveness of strategic decisions and mitigate potential risk factors.

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