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**Estimating the Cost of Injuries among U.S. Army
Soldiers**

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14. ABSTRACT This study established and applied a methodology to calculate the economic burden of mechanical energy injuries among Active Duty (AD) Army Soldiers. Building upon lessons learned from initial estimates of costs for Soldiers' lower extremity fractures, this new, expanded methodology provided more refined cost estimates through inclusion of appointment time for all outpatient visits, and by improving and expanding the limited duty day (LDD) estimates to apply to all injury types. LDDs were derived from a review of previously published Soldier survey responses of injury-related limited duty time. The methodology was applied to mechanical energy injuries that occurred among Army Soldiers in 2018. Data were obtained from the Military Data Repository (MDR) using the Military Health System Mart (M2) interface. Results indicated that the 791,165 incident injuries experienced by Army Soldiers in 2018 resulted in \$4.7B in direct medical and indirect costs. Overall, \$571M (12.1%) of total costs were due to direct medical costs of care paid by the Military Health System (MHS); and \$67M (1.4%) of total costs were due to indirect costs of lost duty time associated with hospital bed days and with hospital bed days and outpatient appointment time. The majority of the total costs associated with mechanical energy injuries was due to the \$4.1B indirect cost of limited duty days (86.6% of total cost). This finding further validates the need to include indirect cost estimates as a part of overall injury costs.					
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Estimating the Cost of Injuries among U.S. Army Soldiers

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1 PURPOSE

This public health investigation is the final phase of the U.S. Army Public Health Center's (APHC's) effort to create a standardized methodology for estimating direct medical costs and indirect costs associated with injuries among Active Duty (AD) U.S. Army Soldiers. This phase expands upon the initial phases, where the methodology was applied to lower extremity (LE) fractures, a single type of acute injury (APHC 2020a; Forrest et al. 2021). This document now provides a comprehensive methodology to estimate costs for Army acute and overuse injuries resulting from a transfer of mechanical energy, to include 97% of all injuries.

2 REFERENCES

Appendix A presents the list of references used within this report.

3 BACKGROUND

3.1 Army Injury Definition

Injury is defined as the damage of or interruption to the normal functioning of body tissues that results when exposure to an intentional or unintentional energy transfer exceeds the threshold of tissue tolerance, either suddenly (acute trauma) or gradually (cumulative microtrauma). Exposures can be to mechanical, thermal/radiant, nuclear, chemical, biological, electrical, or other energy sources. Injuries may also result from the absence of an essential element (e.g., oxygen), or from animate or inanimate sources. Injuries may be caused by single or repetitive events (Hauschild et al. 2019; APHC 2017a). This military-relevant comprehensive injury definition is used by the U.S. Army to conduct injury surveillance. To depict the wide variety of injury types, Figure 1 shows Army injuries are further categorized (Schuh-Renner et al. 2021; Hauschild et al. 2019; APHC 2017a).

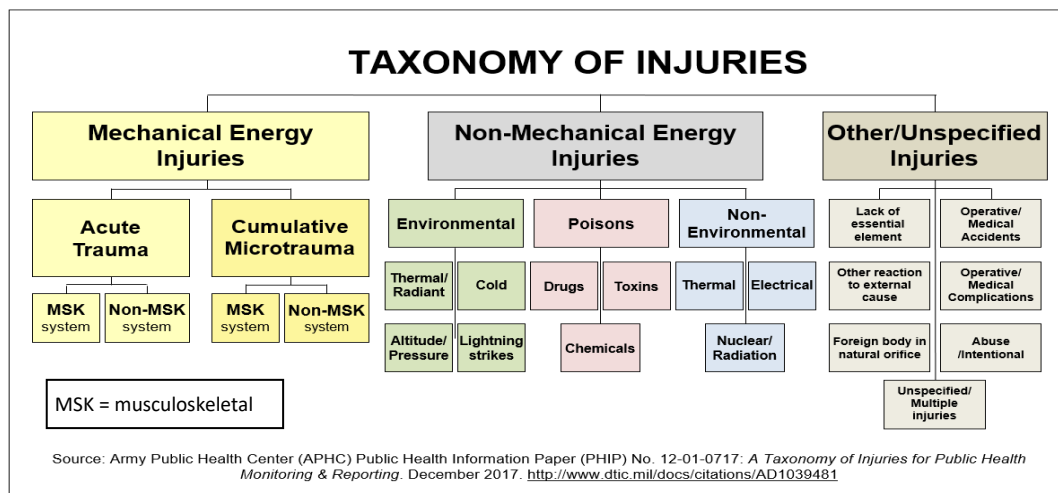


Figure 1. APHC Taxonomy of Injuries

Army injury surveillance data have repeatedly shown that the vast majority (97%) of all injuries experienced by AD Soldier populations are the result of a transfer of mechanical energy (APHC 2021a; Hauschild et al. 2019; Hauschild et al. 2018; APHC 2017a). Mechanical energy injuries occur to musculoskeletal (MSK) and non-musculoskeletal (non-MSK) tissues, and fall into the following two categories:

- Acute trauma (ACT) injuries, which result from a single sudden high force, and
- Cumulative microtraumatic (CMT) or overuse injuries, which are the result of accumulated damage from repetitive lower level forces.

3.2 Army Injury Surveillance and Initial Cost Estimates

Historically, military injury surveillance has reported injuries as the counts of incidents or medical visits, and the number or rates of injured Soldiers. These metrics repeatedly demonstrate that injuries are the leading medical burden to Army personnel (APHC 2021a; APHC 2020b; Hauschild et al. 2019; Jones et al. 2018; Marshall et al. 2014). One critical metric that has not been routinely reported is the significance of these injuries in terms of financial costs. Presenting the injury problem in the context of its financial burden to the military can help inform and prioritize injury prevention initiatives. However, a standardized method for estimating Army injury costs is needed to routinely and consistently report this metric.

Towards this goal, the APHC initiated a multiyear public health investigation of injury cost estimation (APHC 2020a). During Phase 1, a methodology was designed to estimate the health-related cost of injuries as applied to LE fractures. LE fractures, a subset of mechanical energy injuries, were selected for initial focus; this was due to their high visibility and severity in terms of the number of hospitalizations and the amount of recovery time required before a Soldier can return to work at full capacity. The application of the initial injury cost estimation methodology resulted in an estimated cost of LE fractures among U.S. Army Soldiers of approximately \$116M in 2017.

A key finding was that almost 80% of the total costs of LE fractures were attributed to the estimated indirect costs for the injured Soldiers' lost and/or limited duty days (LDDs). Specifically, direct medical costs based on the amount paid for care by the Department of Defense (DOD) military health system (MHS) totaled \$24M, while the indirect costs of the time spent seeking or obtaining health care (lost duty days) and the estimated cost of follow-on recovery time (LDD) totaled nearly \$92M (\$900K and \$91M, respectively). The finding that the majority of injury medical costs were due to loss of productivity associated with lost and LDD validated the significance of indirect costs and emphasized the need to include indirect costs in future injury cost calculations.

3.3 Current Study Objective

This study builds upon lessons learned from Phase 1 estimates of costs of injuries sustained by U.S. Army Soldiers. The new methodology uses the injury taxonomy definition to identify all injuries that result from the transfer of mechanical energy and to refine counts of the number of LDDs. Information from Soldier surveys are used to establish limited duty estimates. The new methodology is applied to mechanical energy injuries occurring among Army Soldiers in 2018.

Estimating costs for mechanical energy injuries will account for the vast majority of costs for all injuries experienced by AD Soldier populations, since such injuries account 97% of injuries. (APHC 2021a; Hauschild et al. 2019; Hauschild et al. 2018; APHC 2017a).

4 METHODS

4.1 Outcomes

The purpose of this public health investigation was to establish a standardized methodology to consistently calculate and report direct and indirect costs for injuries (Changik 2014; Currie et al. 2000; Bonnie et al. 1999; Rice et al. 1985). Direct medical costs include MHS expenditures for diagnosis and treatment of injuries. Indirect costs refer to the cost associated with time away from duties while being treated (lost duty days) and/or to the cost associated with the time to recover and the loss in productivity that occurs when Soldiers are working while injured (LDDs) (Rice 1985; Schultz 2009; Johns 2010; Allen 2018). Both direct and indirect cost outcomes are provided as U.S. dollar estimates.

4.2 Design

The approach utilized a cross-sectional, prevalence-based study design. All injuries meeting study criteria and requiring medical care, both new and ongoing during the calendar year of interest (CY 2018) were included. The resulting estimates are *annual* costs of these injuries, rather than the costs of these injuries over the course of a Soldier's career.

4.3 Population

This methodology was applied to the medical records of the 2018 AD Soldiers of the U.S. Army, which included Army Reserve and National Guard on AD status during the data collection period of interest. Note, although Reserve and National Guard Soldiers are not included in ongoing injury surveillance conducted by the APHC, study investigators decided their inclusion was necessary in the cost methodology to obtain the best estimate of the total cost of the injuries of interest to the Army. This methodological decision can be modified to meet the needs of future studies. The data represent injury-related care paid by the MHS and received at military treatment facilities (MTFs) and networks of private care sector facilities contracted to the DOD MHS to provide care to beneficiaries.

4.4 Injury Identification

The number of incident injuries was identified using the International Classification of Disease Tenth Revision, Clinical Modification (ICD-10-CM) diagnostic codes defined in the APHC Injury Taxonomy (Hauschild et al. 2019; APHC 2017a). The taxonomy categorizes all injuries included in Army public health surveillance, monitoring, and reporting as shown in Figure 1, as well as by causal mechanism and body system (APHC 2017a). The taxonomy is operationalized with ICD-10-CM medical diagnostic codes. The selection of injuries differed from Phase I, where investigators used the CDC injury mortality diagnosis matrix (IDM) to identify specific ICD-10-CM codes (CDC 2006).

The injury case definition was limited to medical encounters for injuries resulting from a mechanical transfer of energy (hereafter referred to as “mechanical energy injuries”), given this taxonomic category routinely encompasses over 97% of injuries among U.S. Army Soldiers (APHC 2021a; Hauschild et al. 2019; Hauschild et al. 2018; APHC 2017a). More than 12,000 ICD-10-CM diagnosis codes are included in this category. Encounters with a mechanical energy injury diagnosis code in the first diagnosis (DX1) position were selected for analysis. Since this expanded methodology also captured ICD-10-CM codes for pain, selection by DX1 alone was deemed adequate. This was a modification to the combined DX1 and DX2 methodology previously used in similar cost analyses, to best align with current Army injury surveillance methodology (Appendix C; APHC 2020a; Forrest et al. 2021).

Finally, consistent with current Army injury surveillance methodology, incident injuries were identified using the full ICD-10-CM code (APHC 2021a; APHC 2020b; Hauschild et al. 2019; APHC 2017a). To decrease the likelihood of counting repeated cases for the same injury, a 60-day incident rule was applied between encounters. The rule states that additional visits for the same six-digit ICD 10-CM diagnosis within 60 days of the first visit for that injury were not counted as a new injury. Follow-ups and sequela visits, based on the seventh digit of ICD-10-CM codes were excluded from the case definition.

4.5 Data Sources

Study population information, including Soldier rank at the time of the encounter and injury encounter data, was extracted from the following MHS Data Repository (MDR) files using the MHS Mart (M2) interface:

- Standard Inpatient Data Report (SIDR) - MTF inpatient records
- Comprehensive Ambulatory Provider Encounter Record (CAPER) –MTF outpatient record
- TRICARE® Encounter Data Institutional (TED-I) – Network inpatient record
- TRICARE Encounter Data Non-Institutional (TED-NI) – Network outpatient record

Based on study design, data extraction programs were written and the population was identified in these databases using the beneficiary category (BENCAT) variable to select AD and Guard/Reserve; the sponsor service set to A (Army); and the family member prefix (FMP) variable set to 20 to identify Service members. Additionally, diagnosis code position one (DX1) was set to the selected ICD-10-CM mechanical energy injury codes obtained from the taxonomy.

Data associated with the injury medical encounter, including the full cost of the visit paid by the MHS, the length of stay or bed days, the amount of time scheduled (assigned) for the outpatient appointment (in minutes), and the encounter dates for inpatient care (including begin date of care, admission date, and discharge date) were also extracted for injuries of interest. Calendar year 2018 Soldier salary data, used in the calculation of indirect cost, were obtained from the Defense Finance and Accounting Service (DFAS) pay charts (DFAS 2018).

4.6 Direct Medical Costs

Direct medical costs represented the cost of care paid by the MHS. For inpatient visits to facilities owned and operated by the military (MTFs), full cost included ancillary laboratory and radiology costs, clinician salary and other salaries (including ancillary and support), as well as costs associated with intensive and surgical care units. For outpatient visits at MHS facilities, full cost included the clinician salary, professional salary, laboratory, radiology, pharmacy, ancillary, support, and other costs. For contracted care provided in civilian or network facilities, the total cost of both inpatient and outpatient care represented the amount paid by TRICARE¹.

4.7 Indirect Costs

Lost and LDDs specifically impact the overall cost estimate, as had been validated in Phase 1 analyses, demonstrating that over 80% costs attributed to indirect costs associated with lost productivity time (APHC 2020a). Calculations of both costs took into consideration the Soldier's compensation by rank at the time of the injury.

4.7.1 Lost Duty Days

Lost duty time was defined as the actual time away from duty associated with injury-related hospitalizations and/or the time to visit a clinic and provider offices. The amount of time lost—number of bed days and assigned appointment duration—was available in the data extracted for each medical encounter.

4.7.2 Limited Duty Days

While the amount of time associated with lost duty days (bed days and appointment time) was extracted from M2 files, the number of LDDs or the time when a Soldier either could not participate in their military occupational and physical training tasks and/or performed these tasks at diminished capacity due to the injury (e.g., working while injured) were based on estimates. Past estimates of LDDs suggested or relied on broad estimates (120, 90, 60, or 30 LDD) by injury type (Ruscio et al. 2010; Hauschild et al. 2018). To provide more precise LDD estimates, Soldier survey responses of estimated LDDs by injury type were compiled. Table 1 shows the resulting LDD estimates.

LDD estimates were based on three surveys summarized in Appendix B (APHC 2017b; APHC 2018; Canham-Chervak et al. 2018). The original goals of these survey investigations were to assess injuries and potential injury risk factors. Among various other questions, the surveys asked Soldiers to report how many injuries they had experienced in the previous year. Follow up questions about the reported injuries requested details about the resulting days of lost or restricted duty, including temporary profiles.

For each study, survey results reported injuries by type and limited duty (summarized in Tables B-1, B-2, and B-3). Due to differences in study populations, each survey used slightly different terms and questions and had differences in reported injuries. Therefore, the three sets of survey

¹ TRICARE is the DOD MHS managed service healthcare program

results were merged and re-analyzed for combined consideration in the current investigation (see Tables B-4, B-5, and B-6). Specifically, for each injury type (i.e., tear, fracture, dislocation), the number of injuries that resulted in LDDs (temporary profiles/restricted duty) from all surveys was combined and divided by the total LDDs reported for that injury type. This process ensured that the specific injuries that were more common were reflected in the final LDD estimates selected for the broader taxonomy categories.

Since the injury types offered as survey response options did not always align with the established injury taxonomy categories (APHC 2017a, Addendum 1 Table 2) and in some cases varied between surveys, investigators could not directly map all survey injury types to corresponding taxonomy injury categories. Therefore, a final step in the determination of LDD estimates involved subject matter expert (SME) review of the survey-based LDD averages and weighted averages (Tables B-4, B-5, and B-6). For all but one category, the survey LDD weighted averages were retained. For Nerve injury (weighted average = 59 days), the decision was made to use 24 days as the LDD estimate. This decision was based on investigators' expectation of an average of between 14 and 30 days for this injury type since there were a relatively small portion of nerve injuries with a temporary profile, and the desire to decrease the likelihood of overestimation of costs. For all LDD estimates, the lowest weighted average across injury types in the taxonomy injury category was chosen for use in subsequent cost estimates.

Table 1. Limited Duty Day (LDD) Estimates for Indirect Cost Estimation of Injuries by Taxonomy Injury Type Categories, AD Soldiers

Taxonomy Injury Type	Survey Injury Types ^a	LDD Estimate used for Indirect Cost Estimates
Contusion/Superficial	Abrasion, Bruise; Contusion; Blister	24
Crush	Blunt force trauma	37
Dislocation	Dislocation	56
Fracture	Fracture; Fracture/break	63
Internal Organ & Blood Vessel	--	7 ^e
MSK Tissue Damage, Other	Pain; unspecified pain (Bursitis) (Fasciitis) (Hernia)	33
Nerve	Nerve injury	24 ^c
Open Wound	Cut/laceration/puncture	34
Sprain/Joint Damage	Sprain Sprain/Strain	26
Strain/Tear	Strain/Tear Sprain/Strain Tear (Spasms)	49
Tissue Damage, Other	--	7 ^b
Amputation	--	365 ^d

Notes:

^a Injury types and LDD averages obtained from 3 datasets containing over 7,000 Soldier surveys (details in Appendix B)^b Used lowest estimate (7 days) in line with Ruscio et al. (2010) recommendation for "unspecified" acute injuries. Some diagnoses in these groups (hearing loss, concussions), were not LE so not considered during this initial phase two methodology^c Resulting estimated of 59 LDD seems high to investigators who had expected an average of between 14 and 30 days for this injury type. Given these suspicions, and that there were a relatively small portion of nerve injuries that lead to Temporary profile, 24 days was chosen as conservative estimate to avoid overestimation of costs^d Amputations estimate based on Cross et al. (2011), Stinner et al. (2010), and Tennent et al. (2014).^e Used lowest estimate (7 days) in line with Ruscio et al. (2010) recommendation for "unspecified" acute injuries.

4.8 Cost Estimate Analyses

Data were extracted, downloaded, and analyzed using SAS® V9.2. Analysis of injuries of interest resulting in inpatient and outpatient medical records were stratified by taxonomy category (e.g., musculoskeletal (MSK) and Non-MSK; acute trauma (ACT) and cumulative microtrauma (CMT)) and by injured anatomical site. The total population considered was the number of Soldiers with at least one mechanical energy injury during the study period, which is based on the number of unique patient identifiers assigned by the DOD among the encounter data. Total encounters are the sum of all Soldier outpatient and inpatient encounters with the selected mechanical energy injury taxonomy codes in CY 2018. The total number of incident injuries was based on the 60-day incidence rule described above (see section 4.4). Total cost was calculated as the sum of direct medical costs and indirect costs. The following provides more information about these costs:

- Direct Medical Cost. To determine the direct care cost of the injuries of interest, investigators captured and summed all costs assigned to all encounters with a mechanical energy injury ICD-10-CM code in DX1. The data are reported overall and by injury mechanism and anatomical site.
- Indirect Cost, Lost Duty Time. In this study, lost duty time associated with mechanical energy injuries was based on the length of a hospital stay and on the amount of time scheduled for an appointment at MHS outpatient facilities. Lost duty time was obtained from the medical encounter data. For hospital stays at both MTF and network facilities, investigators assumed 8 hours of lost time for each bed day; lost duty time cost was estimated by multiplying the Soldier's hourly salary by the number of 8-hour bed days. These costs were summed across all injured Soldiers to obtain total inpatient lost duty time costs. Lost duty time for outpatient care was based on the time scheduled for an appointment. The inclusion of appointment duration is a modification to the prior methodology (Forrest et al. 2021). The amount of time scheduled for an appointment was available for outpatient visits to an MTF, with the unit of time reported in minutes. For each injury of interest, investigators summed the time by the respective DX1 ICD-10-CM codes and by Soldier, then divided the total by 60 to obtain the number of hours for each Soldier. Investigators also developed averages of the number of hours for each of the ICD-10-CM injury codes by summing the hours and dividing by the total number of encounters for a given ICD injury code. These averages were used as a substitute for the missing data in the network facilities' file (TEDNI), where no assigned appointment time was available.
- Indirect Cost, Limited Duty Days. LDDs were not assigned to every identified incident injury (Table 1). Investigators applied limited duty time by anatomical site (e.g., foot, toe, leg) and injury type (e.g., sprains, strains, fractures). Anatomical site and injury type information for each DX1 code was obtained from the taxonomy (APHC 2017a). A conservative approach was taken, assigning LDDs for a given Soldier to only the first occurrence or earliest date of an injury type (e.g., fracture, sprain) in an anatomical site (e.g., foot, toe) for a given Soldier. Further, the limited duty time was applied only one time every 60 days thereafter. The use of the anatomical site and injury type to refine decisions about when to apply LDDs differed from methodology used in the initial (Phase 1) LE fracture methodology, where the respective number of LDDs was applied to each of the incident injuries. Appendix D provides details of the difference in the number of

LDDs assigned using the two methodologies and the resulting cost differences. Since limited duty, as opposed to lost duty, may not be completely limiting, indirect costs based on 50% limited duty were also calculated, according to previous military cost estimations (Altarum Institute 2006).

5 RESULTS

In 2018, some 348,506 AD Army Soldiers received care in the MHS for a total of 791,165 mechanical energy-related injuries (Table 2). These injuries represented more than 2.55 million (M) encounters, required more than 1.5M hours of outpatient care, and 14.8 thousand (K) days of inpatient care.

Table 3 shows direct medical cost and indirect costs for these injuries. These data are displayed by the percentage of anticipated limitation in duties occurring during limited duty days. At 100% limitation, Soldiers are not able to complete any duties when they are on limited duty; at 50% limitation, Soldiers, on average, complete 50% of assigned duties when on limited duty. The following provides more information about the 100% and 50% duty limitations:

- **100% duty limitation:** When the injury results in 100% duty limitation, the cost of the 791,165 mechanical energy injuries experienced by Army Soldiers in 2018 totaled \$4.7 billion (B) in direct and indirect costs. Overall, \$571M (12.1%) of total costs was due to direct medical costs of care paid by the MHS; \$67M (1.4%) of total costs was due to indirect costs of lost duty time. This lost duty time was associated with hospital bed days and outpatient assigned time for the visit. The majority of the total costs associated with mechanical energy injuries were due to the indirect costs of limited duty days, which were \$4.1B (86.6% of total cost). The mean cost per mechanical energy injury in 2018 at 100% limitation was \$5,962 (\$4,717,235,033/791,165), while the cost per encounter was \$1,824 (\$4,717,235,033/ 2,586,773).
- **50% duty limitation:** Direct medical costs and lost duty cost do not change when limited duty results in 50% limitation. The cost of the 791,165 mechanical energy injuries experienced by Army Soldiers in 2018 totaled \$2.7B in direct and indirect costs. Overall, 76% of total costs (\$2B) were associated with limited duty. The average cost per injury at 50% limitation was \$3,388, while the average cost per encounter was \$1,037.

Table 2. Summary of Mechanical Energy Injuries, AD Soldiers, CY 2018

All Injuries (N)	
Total Soldiers ^a	348,506
Total Injuries ^b	791,165
Total Encounters	2,586,773
Inpatient Bed Days	14,841
Outpatient Scheduled (Assigned) Appointment Time (hours)	1,519,613
Limited Duty Days ^c	24,439,709

Notes:

^a Total number of individuals with >1 mechanical energy injury. Includes activated Guard and Reserves.

^b 60-day incidence rule based on Dx1 was used to determine the number of injuries.

^c Limited duty days were not applied to all incident injuries. APHC Injury Taxonomy variables 'injury type' and 'body region 2' were used to determine the injuries that incurred limited duty days.

Table 3. Summary of Mechanical Energy Injuries Costs, AD Soldiers, CY 2018

Cost (\$)				
	Limited duty results in 100% Limitation		Limited duty results in 50% Limitation	
Total Cost	\$4,717,235,033	100%	\$2,680,304,332	100%
Direct Medical Cost	\$570,759,713	12.1%	\$570,759,713	21.3%
Indirect Lost Duty Cost	\$67,145,876	1.4%	\$67,145,876	2.5%
Indirect Limited Duty Cost ^a	\$4,084,797,485	86.6%	\$2,042,398,743	76.2%

Note:

^a Limited duty days were not applied to all incident injuries. APHC Injury Taxonomy variables 'injury type' and 'body region 2' were used to determine the injuries that incurred limited duty days.

5.1 Injury Distribution and Estimated Costs of Mechanical Energy Injuries by Body System

5.1.1 Injuries

Table 4 shows information on the distribution of mechanical energy injuries, encounters, and limited duty days by body system (non-MSK vs. MSK).

Non-MSK mechanical energy injuries accounted for 14.6% of all injuries. When reviewed by acute (ACT) versus overuse (CMT) injuries (Table 4), over 60% of non-MSK injuries were acute injuries (60.6%). Looking at encounters and limited duty days, these acute non-MSK injuries accounted for just over half (50.6%) of all non-MSK encounters, as well as the majority of outpatient appointment time (66.1%), hospital bed days (95.6%), and limited duty days (62.8%) among non-MSK mechanical energy injuries.

Overall, 85.4% (n=675,354) of the mechanical energy injuries were to the MSK system. MSK injuries resulted in over 2.38M encounters (92% of mechanical injury encounters), 1.3M outpatient appointment time (88.0% of hours), more than 11K hospital bed-days (74.6%), and 22.3M limited duty days (91.2%). The majority of MSK mechanical energy injuries (Table 4) were due to overuse (86.9%). These CMT injuries also accounted for the majority of MSK injury encounters (93.1%), outpatient appointment time (89.4%), and limited duty days (84.0%). However, acute MSK injuries accounted for a higher percentage of hospital bed days (50.8%) compared to overuse injuries.

5.1.2 Cost

Table 5 shows information on the distribution of costs for mechanical energy injuries by body system where duty limitations are 100%; Appendix D shows costs for duty limitations at 50%.

Where duty limitations are 100% (Table 5), non-MSK injuries accounted for 9.3% of the cost of these injuries. When reviewed by acute non-MSK and overuse non-MSK strata, acute non-MSK injuries were associated with more than 60% of the total cost, direct medical cost, and indirect

cost of non-MSK injuries. Similar results were found when duty limitations were considered at 50% (Appendix D).

Overall 90.7% (\$4.3B) of the estimated total cost of mechanical energy injuries were associated with MSK injuries. MSK injuries also accounted for approximately 87% of direct medical and non-medical costs, as well as 91.3% of total limited duty costs for mechanical energy injuries among Active Duty Army Soldiers in 2018. Among these MSK mechanical energy injuries, overuse injuries were associated with the majority of estimated MSK injury costs to include 83.7% (\$3.6B) of the total cost of MSK injuries, 74.8% of direct medical costs, and more than 85% of indirect medical costs; this was due to lost duty (e.g., hospital bed days and outpatient appointment time costs) and the indirect costs associated with limited duty days. When limited duty was estimated at 50% duty limitation, the distribution of costs were similar, when comparing MSK to Non-MSK injuries and acute to overuse injuries (Table D-1).

Table 6 provides estimates of medical costs for mechanical energy injuries and encounters by body system, where limited duty resulted in 100% limitations. On average, the estimated total cost per mechanical injury encounter was \$1,824. Non-MSK injuries were more costly per encounter compared to MSK injuries (\$2,120 per non-MSK injury versus \$1,798 per MSK injury). However, MSK injuries were more costly per injury (\$6,338 per MSK injury versus \$3,770 per non-MSK injury). Across MSK and non-MSK injuries, acute injuries were the most costly per injury and per encounter. When duty limitations were considered at 50% (Table D-2), the estimated total cost per mechanical injury encounter was \$1,036 and the cost per injury averaged \$3,388.

5.2 Injury Distribution and Estimated Costs of Mechanical Energy Injuries by Body Region and Anatomical Site

5.2.1 Injuries

Table 7 shows information on the distribution of mechanical energy injuries by body region and anatomical site. By body region, the majority of injuries were associated with the lower extremities (n=348K, 44.0%) and spine/back (195K, 24.7%). These two body regions were also associated with the majority of encounters (42.6% and 29.1%, respectively), outpatient appointment hours (39.1% and 27.1%, respectively), and limited duty days (46.7% and 25.7%, respectively). Based on the number of Soldiers injured, injuries to the lower back ranked number 1, followed by knee injuries (#2) and shoulder injuries (#3) in 2018.

5.2.2 Cost

Table 8 shows information on the cost of mechanical energy injuries by body region and anatomical site (where duty limitations were 100%). The two body regions associated with the most injuries—lower extremity and spine/back injuries—were also associated with the majority of cost (\$3.3B of the \$4.7B), as well as the majority of indirect cost associated with lost duty days (63.9%) and the indirect cost associated with limited duty days (71.9%). Lower extremity injuries and upper extremity injuries accounted for the majority of the direct medical cost of mechanical energy injuries (\$220M (38.5%) and \$142M (25.0%), respectively). More than 30% of the cost of lower extremity injuries was due to knee injuries (32.6% of total costs; 39% of direct medical costs and indirect cost due to lost duty time; and 31.8% of indirect costs due to

limited duty time). Across the direct and indirect costs of spine/back injuries, lower back injuries were associated with more than 65% of the cost. Results are similar when mechanical energy injuries by body region and anatomical site (where duty limitations were 50%) were examined (Table D-3).

Table 9 provides estimates of the cost per injury and encounter by body region and anatomical sites for mechanical energy injuries, where the injury resulted in 100% limitations. The most costly injuries were upper extremity injuries (\$6,744 per injury), followed by spine/back injuries (\$6,558 per injury). By anatomical site, upper arm (\$8,231 per injury) and shoulder (\$7,087 per injury) injuries were the most costly upper extremity injuries; upper back (\$6,915 per injury) and lower back (\$6,559 per injury) were the most costly spine/back injuries. When the data were examined by encounter, torso injuries were the most costly (\$3,614 per encounter); the next most costly encounters were associated with head/neck injuries at \$2,150 per encounter.

Table D-4 provides estimates of the cost per injury and encounter by body region and anatomical site for mechanical energy injuries, if it is estimated that the injury resulted in 50% limitations. The same cost pattern emerged, and the average cost per injury was \$3,388. The most costly injuries were upper extremity injuries (\$3,870 per injury), followed by spine/back injuries (\$3,665 per injury) and lower extremity injuries (\$3,288 per injury). By anatomical site, shoulder (\$4,160 per injury) and upper arm (\$4,910 per injury) injuries were the most costly upper extremity injuries; upper back (\$3,886 per injury) and lower back (\$3,688 per injury) were the most costly spine/back injuries; and knee (\$3,453) and hip (\$3,411) were the most costly lower extremity injuries. When the data were examined by encounter, instead of by injury, torso injuries (\$2,151 per encounter) and head and neck injuries (\$1,341 per encounter) were the most costly.

Table 4. Distribution of Mechanical Energy Injuries, Encounters and Limited Duty Days by Body System (non- musculoskeletal (MSK) and MSK), AD Soldiers, CY 2018

Body System	Soldiers Injured		Total Injuries		Total Encounters		Outpatient Appointment Time (Hour)		Hospital Bed Days		Limited Duty Days	
	N	% Total Soldiers	N	% All	N	% All	N	% All	N	% All	N	% All
	348,506		791,165		2,586,773		1,519,613		14,841		24,439,709	
All Non-MSK	N/A		115,811	14.6	206,011	8.0	181,951	12.0	3,773	25.4	2,157,268	8.8
Acute, Non-MSK	59,288	17.0	70,216	60.6	104,176	50.6	120,337	66.1	3,608	95.6	1,354,487	62.8
Overuse, Non-MSK	38,280	11.0	45,595	39.4	101,835	49.4	61,614	33.9	165	4.4	802,781	37.2
All MSK	N/A		675,354	85.4	2,380,762	92.0	1,337,662	88.0	11,068	74.6	22,282,441	91.2
Acute, MSK	75,505	21.7	88,537	13.1	164,077	6.9	142,437	10.6	5,619	50.8	3,571,534	16.0
Overuse, MSK	315,974	90.7	586,817	86.9	2,216,685	93.1	1,195,225	89.4	5,449	49.2	18,710,907	84.0

Table 5. Distribution of Costs, Mechanical Energy Injuries by Body System Where Duty Limitations were 100%, AD Soldiers, CY 2018

Body System	Total cost		Direct Medical Cost		Indirect Cost - Lost Duty		Indirect Cost - Limited Duty	
	N	% All	N	% All	N	% All	N	% All
	\$4,717,235,033	100	\$570,759,713	12.1	\$67,145,876	1.4	\$4,084,797,485	86.6
All Non-MSK	\$436,655,282	9.3	\$72,045,319	12.6	\$8,790,473	13.1	\$356,425,011	8.7
Acute, Non-MSK	\$270,736,800	62.0	\$47,278,037	65.6	\$6,009,351	68.4	\$217,810,808	61.1
Overuse, Non-MSK	\$165,918,482	38.0	\$24,767,282	34.4	\$2,781,122	31.6	\$138,614,203	38.9
All MSK	\$4,280,579,751	90.7	\$498,714,394	87.4	\$58,355,403	86.9	\$3,728,372,474	91.3
Acute, MSK	\$696,453,794	16.3	\$125,745,893	25.2	\$7,294,718	12.5	\$566,046,902	15.2
Overuse, MSK	\$3,584,125,957	83.7	\$372,968,501	74.8	\$51,060,685	87.5	\$3,162,325,572	84.8

Table 6. Estimates of Costs for Mechanical Energy Injuries Resulting in Medical Encounters, by Body System where Duty Limitations were 100%, AD Soldiers, CY 2018

Body System	Total cost, 100% Limitation		Total Injuries		Total Encounters	
	N	% All	N	Cost per Injury	N	Cost per Encounter
	\$4,717,235,033	100	791,165	\$5,962	2,586,773	\$1,824
All Non-MSK	\$436,655,282	9.3	115,811	\$3,770	206,011	\$2,120
Acute, Non-MSK	\$270,736,800	62.0	70,216	\$3,856	104,176	\$2,599
Overuse, Non-MSK	\$165,918,482	38.0	45,595	\$3,639	101,835	\$1,629
All MSK	\$4,280,579,751	90.7	675,354	\$6,338	2,380,762	\$1,798
Acute, MSK	\$696,453,794	16.3	88,537	\$7,866	164,077	\$4,245
Overuse, MSK	\$3,584,125,957	83.7	586,817	\$6,108	2,216,685	\$1,617

Table 7. Distribution of Mechanical Energy Injuries, Encounters, and Limited Duty Days by Body Region and Anatomical Site, AD Soldiers, CY 2018

Body Region	Rank	Soldiers Injured		Total Injuries		Total Encounters		Outpatient Appointment Time (Hour)		Hospital Bed Days		Estimated Limited Duty Days	
Anatomical Site		N	%	N	%	N	%	N	%	N	%	N	%
		348,506		791,165		2,586,773		1,519,613		14,841		24,439,709	
1 Head & Neck		42,122	12.1	44,493	5.6	70,053	2.7	78,569	5.2	2,905	19.6	692,250	2.8
01 TBI*	22	4,875	11.6	5,030	11.3	9,705	13.9	12,213	15.5	2,073	71.4	45,470	6.6
02 OTHER HEAD	32	76	0.2	77	0.2	130	0.2	101	0.1	2	0.1	240	0.0
03 FACE	27	2,887	6.9	3,011	6.8	4,940	7.1	5,914	7.5	568	19.6	102,824	14.9
04 EYE	24	5,396	12.8	5,526	12.4	8,517	12.2	8,142	10.4	73	2.5	116,238	16.8
05 EAR	17	16,566	39.3	17,993	40.4	27,723	39.6	21,807	27.8	16	0.6	137,379	19.8
06 NECK	26	4,173	9.9	4,323	9.7	5,879	8.4	8,879	11.3	43	1.5	151,857	21.9
07 HEAD/NECK OTHER	18	8,149	19.3	8,533	19.2	13,159	18.8	21,513	27.4	130	4.5	138,242	20.0
2 Spine & Back		150,130	43.1	195,068	24.7	752,641	29.1	412,132	27.1	1,822	12.3	6,289,509	25.7
08 BACK, UPPER	6	27,995	18.6	36,026	18.5	142,445	18.9	75,500	18.3	534	29.3	1,142,737	18.2
09 BACK, MIDDLE	16	10,492	7.0	11,659	6.0	30,032	4.0	16,544	4.0	273	15.0	385,262	6.1
10 BACK, LOWER	1	95,804	63.8	130,201	66.7	546,208	72.6	302,925	73.5	999	54.8	4,197,259	66.7
11 BACK, OTHER	14	15,839	10.6	17,182	8.8	33,956	4.5	17,163	4.2	16	0.9	564,251	9.0
3 Torso		10,290	3.0	10,651	1.3	16,543	0.6	15,779	1.0	1,349	9.1	318,631	1.3
12 CHEST	21	5,927	57.6	6,195	58.2	9,828	59.4	9,510	60.3	477	35.4	185,084	58.1
13 ABDOMEN	29	1,524	14.8	1,537	14.4	2,331	14.1	2,455	15.6	200	14.8	40,288	12.6
14 PELVIS	28	2,773	26.9	2,853	26.8	4,290	25.9	3,782	24.0	541	40.1	93,042	29.2
15 TRUNK, OTHER	33	66	0.6	66	0.6	94	0.6	32	0.2	131	9.7	217	0.1

Body Region Anatomical Site	Rank	Soldiers Injured		Total Injuries		Total Encounters		Outpatient Appointment Time (Hour)		Hospital Bed Days		Estimated Limited Duty Days	
		N	%	N	%	N	%	N	%	N	%	N	%
		348,506		791,165		2,586,773		1,519,613		14,841		24,439,709	
4 Upper Extremity		129,272	37.1	159,749	20.2	585,829	22.6	355,206	23.4	1,599	10.8	531,124	21.7
16 SHOULDER	3	54,403	42.1	72,331	45.3	364,385	62.2	204,615	57.6	317	19.8	2,422,296	45.6
17 ARM, UPPER	25	3,485	2.7	3,631	2.3	6,895	1.2	5,149	1.4	303	18.9	146,316	2.8
18 ELBOW	11	13,627	10.5	16,315	10.2	57,875	9.9	34,660	9.8	57	3.6	491,127	9.2
19 ARM, LOWER	19	6,977	5.4	7,340	4.6	12,338	2.1	10,024	2.8	386	24.1	189,851	3.6
20 WRIST	9	19,947	15.4	24,382	15.3	70,436	12.0	40,711	11.5	140	8.8	767,634	14.5
21 HAND, FINGER	10	27,085	21.0	31,840	19.9	64,735	11.1	54,832	15.4	373	23.3	1,168,323	22.0
22 ARM, OTHER	23	3,748	2.9	3,910	2.4	9,165	1.6	5,215	1.5	23	1.4	125,696	2.4
5 Lower Extremity		288,021	82.6	348,286	44.0	1,100,803	42.6	593,653	39.1	3,654	24.6	11,420,663	46.7
23 HIP	5	37,282	12.9	45,219	13.0	190,439	17.3	97,303	16.4	542	14.8	1,480,894	13.0
24 LEG, UPPER	15	15,171	5.3	16,310	4.7	31,774	2.9	17,319	2.9	651	17.8	600,958	5.3
25 KNEE	2	86,413	30.0	110,623	31.8	444,239	40.4	240,780	40.6	650	17.8	3,580,607	31.4
26 LEG, LOWER	8	32,127	11.2	36,567	10.5	82,142	7.5	48,034	8.1	939	25.7	1,224,919	10.7
27 ANKLE	4	50,094	17.4	61,698	17.7	191,704	17.4	108,098	18.2	485	13.3	1,978,312	17.3
28 FOOT, TOE	7	52,144	18.1	61,820	17.7	123,588	11.2	63,123	10.6	324	8.9	2,037,476	17.8
29 LEG, OTHER	13	14,790	5.1	16,049	4.6	36,917	3.4	18,996	3.2	63	1.7	517,497	4.5
6 Other		30,824	8.8	32,918	4.2	60,904	2.4	64,274	4.2	3,512	23.7	407,413	1.7
30 SYSTEMWIDE	20	6,699	21.7	6,870	20.9	11,758	19.3	19,347	30.1	1,061	30.2	3,698	0.9
31 MULTIPLE	30	1,488	4.8	1,550	4.7	2,261	3.7	1,293	2.0	234	6.7	12,309	3.0
32 UNSPECIFIED	12	22,637	73.4	24,498	74.4	46,885	77.0	43,634	67.9	2,217	63.1	391,406	96.1

Note:

* Traumatic Brain Injury

Table 8. Distribution of Costs for Mechanical Energy Injuries Resulting in Medical Encounters by Body Region and Anatomical Site where Duty Limitations were 100%, AD Soldiers, CY 2018

Body Region	Total Cost		Direct Medical Cost		Indirect Cost – Lost Duty		Indirect Cost – Limited Duty	
Anatomical Site	N	%	N	%	N	%	N	%
	\$4,717,235,033	100	\$570,759,713	12.1	\$67,145,876	1.4	\$4,084,797,485	86.6
1 Head & Neck	\$150,593,313	3.2	\$32,888,064	5.8	\$4,242,663	6.3	\$113,690,010	2.8
01 TBI*	\$19,275,349	12.8	\$11,007,932	33.5	\$1,180,989	27.8	\$7,144,151	6.3
02 OTHER HEAD	\$77,012	0.1	\$40,136	0.1	\$4,680	0.1	\$32,197	0.0
03 FACE	\$21,028,625	14.0	\$4,809,738	14.6	\$410,885	9.7	\$15,848,184	13.9
04 EYE	\$22,363,860	14.9	\$2,873,970	8.7	\$360,338	8.5	\$19,178,314	16.9
05 EAR	\$33,829,393	22.5	\$6,692,732	20.4	\$1,065,993	25.1	\$26,094,510	23.0
06 NECK	\$26,534,329	17.6	\$2,098,461	6.4	\$346,475	8.2	\$24,092,372	21.2
07 HEAD/NECK OTHER	\$27,484,745	18.3	\$5,365,095	16.3	\$873,303	20.6	\$21,300,282	18.7
2 Spine & Back	\$1,279,223,645	27.1	\$131,599,587	23.1	\$18,380,131	27.4	\$1,129,704,715	27.7
08 BACK, UPPER	\$249,109,342	19.5	\$27,262,101	20.7	\$3,544,606	19.3	\$218,408,240	19.3
09 BACK, MIDDLE	\$74,160,606	5.8	\$5,954,780	4.5	\$763,065	4.2	\$67,507,860	6.0
10 BACK, LOWER	\$854,005,370	66.8	\$92,707,613	70.4	\$13,336,396	72.6	\$748,225,279	66.2
11 BACK, OTHER	\$101,948,327	8.0	\$5,675,093	4.3	\$736,064	4.0	\$95,563,336	8.5
3 Torso	\$59,783,557	1.3	\$10,199,005	1.8	\$1,091,861	1.6	\$48,601,899	1.2
12 CHEST	\$35,206,447	58.9	\$4,741,717	46.5	\$538,002	49.3	\$30,008,494	61.7
13 ABDOMEN	\$7,965,802	13.3	\$1,565,922	15.4	\$167,916	15.4	\$6,244,844	12.8
14 PELVIS	\$16,071,432	26.9	\$3,417,140	33.5	\$354,557	32.5	\$12,314,301	25.3
15 TRUNK, OTHER	\$539,876	0.9	\$474,226	4.6	\$31,386	2.9	\$34,260	0.1

Body Region	Total Cost		Direct Medical Cost		Indirect Cost – Lost Duty		Indirect Cost – Limited Duty	
Anatomical Site	N	%	N	%	N	%	N	%
	\$4,717,235,033	100	\$570,759,713	12.1	\$67,145,876	1.4	\$4,084,797,485	86.6
4 Upper Extremity	\$1,077,324,441	22.8	\$142,474,701	25.0	\$15,294,551	22.8	\$920,993,885	22.5
16 SHOULDER	\$512,589,814	47.6	\$80,081,199	56.2	\$8,421,401	55.1	\$424,773,567	46.1
17 ARM, UPPER	\$29,886,873	2.8	\$5,423,906	3.8	\$309,546	2.0	\$24,186,744	2.6
18 ELBOW	\$105,666,125	9.8	\$11,493,596	8.1	\$1,615,976	10.6	\$92,670,613	10.1
19 ARM, LOWER	\$38,348,982	3.6	\$6,907,113	4.8	\$526,189	3.4	\$31,076,434	3.4
20 WRIST	\$150,532,171	14.0	\$15,615,544	11.0	\$1,804,166	11.8	\$133,241,110	14.5
21 HAND, FINGER	\$216,329,864	20.1	\$21,496,371	15.1	\$2,383,800	15.6	\$192,761,596	20.9
22 ARM, OTHER	\$23,970,612	2.2	\$1,456,972	1.0	\$233,473	1.5	\$22,283,821	2.4
5 Lower Extremity	\$2,043,262,667	43.3	\$219,809,737	38.5	\$24,497,675	36.5	\$1,801,841,310	44.1
23 HIP	\$268,336,636	13.1	\$36,054,477	16.4	\$3,932,262	16.1	\$228,482,449	12.7
24 LEG, UPPER	\$100,612,750	4.9	\$9,526,775	4.3	\$907,084	3.7	\$90,227,754	5.0
25 KNEE	\$666,469,672	32.6	\$86,080,039	39.2	\$9,638,902	39.3	\$572,302,268	31.8
26 LEG, LOWER	\$206,065,036	10.1	\$20,879,106	9.5	\$2,126,755	8.7	\$183,323,254	10.2
27 ANKLE	\$349,336,862	17.1	\$33,200,836	15.1	\$4,485,597	18.3	\$312,060,766	17.3
28 FOOT, TOE	\$366,034,033	17.9	\$27,821,921	12.7	\$2,679,317	10.9	\$335,923,392	18.6
29 LEG, OTHER	\$86,407,678	4.2	\$6,246,583	2.8	\$727,758	3.0	\$79,521,427	4.4
6 Other	\$107,047,410	2.3	\$33,788,619	5.9	\$3,638,995	5.4	\$69,965,666	1.7
30 SYSTEMWIDE	\$10,334,853	9.7	\$8,811,794	26.1	\$1,083,693	29.8	\$571,408	0.8
31 MULTIPLE	\$5,863,802	5.5	\$4,472,765	13.2	\$113,005	3.1	\$1,364,616	2.0
32 UNSPECIFIED	\$90,848,755	84.9	\$20,504,060	60.7	\$2,442,297	67.1	\$68,029,642	97.2

Note:

*Traumatic Brain Injury

Table 9. Estimates of Costs, Mechanical Energy Injuries Resulting in Medical Encounters by Body Region and Anatomical Site where Duty Limitations were 100%, AD Soldiers, CY 2018

Body Region	Total cost where Duty Limitations were 100%		Total Injuries		Total Encounters	
Anatomical Site	N	%	N	Cost per Injury	N	Cost per Encounter
	\$4,717,235,033	100	791,165	\$5,962	2,586,773	\$1,824
1 Head & Neck	\$150,593,313	3.2	44,493	\$3,385	70,053	\$2,150
01 TBI*	\$19,275,349	12.8	5,030	\$3,832	9,705	\$1,986
02 OTHER HEAD	\$77,012	0.1	77	\$1,000	130	\$592
03 FACE	\$21,028,625	14.0	3,011	\$6,984	4,940	\$4,257
04 EYE	\$22,363,860	14.9	5,526	\$4,047	8,517	\$2,626
05 EAR	\$33,829,393	22.5	17,993	\$1,880	27,723	\$1,220
06 NECK	\$26,534,329	17.6	4,323	\$6,138	5,879	\$4,513
07 HEAD/NECK OTHER	\$27,484,745	18.3	8,533	\$3,221	13,159	\$2,089
2 Spine & Back	\$1,279,223,645	27.1	195,068	\$6,558	752,641	\$1,700
08 BACK, UPPER	\$249,109,342	19.5	36,026	\$6,915	142,445	\$1,749
09 BACK, MIDDLE	\$74,160,606	5.8	11,659	\$6,361	30,032	\$2,469
10 BACK, LOWER	\$854,005,370	66.8	130,201	\$6,559	546,208	\$1,564
11 BACK, OTHER	\$101,948,327	8.0	17,182	\$5,933	33,956	\$3,002
3 Torso	\$59,783,557	1.3	10,651	\$5,613	16,543	\$3,614
12 CHEST	\$35,206,447	58.9	6,195	\$5,683	9,828	\$3,582
13 ABDOMEN	\$7,965,802	13.3	1,537	\$5,183	2,331	\$3,417
14 PELVIS	\$16,071,432	26.9	2,853	\$5,633	4,290	\$3,746
15 TRUNK, OTHER	\$539,876	0.9	66	\$8,180	94	\$5,743

Body Region	Total cost where Duty Limitations were 100%		Total Injuries		Total Encounters	
Anatomical Site	N	%	N	Cost per Injury	N	Cost per Encounter
	\$4,717,235,033	100	791,165	\$5,962	2,586,773	\$1,824
4 Upper Extremity	\$1,077,324,441	22.8	159,749	\$6,744	585,829	\$1,839
16 SHOULDER	\$512,589,814	47.6	72,331	\$7,087	364,385	\$1,407
17 ARM, UPPER	\$29,886,873	2.8	3,631	\$8,231	6,895	\$4,335
18 ELBOW	\$105,666,125	9.8	16,315	\$6,477	57,875	\$1,826
19 ARM, LOWER	\$38,348,982	3.6	7,340	\$5,225	12,338	\$3,108
20 WRIST	\$150,532,171	14.0	24,382	\$6,174	70,436	\$2,137
21 HAND, FINGER	216,329,864	20.1	31,840	\$6,794	64,735	\$3,342
22 ARM, OTHER	\$23,970,612	2.2	3,910	\$6,131	9,165	\$2,615
5 Lower Extremity	\$2,043,262,667	43.3	348,286	\$5,867	1,100,803	\$1,856
23 HIP	\$268,336,636	13.1	45,219	\$5,934	190,439	\$1,409
24 LEG, UPPER	\$100,612,750	4.9	16,310	\$6,169	31,774	\$3,167
25 KNEE	\$666,469,672	32.6	110,623	\$6,025	444,239	\$1,500
26 LEG, LOWER	\$206,065,036	10.1	36,567	\$5,635	82,142	\$2,509
27 ANKLE	\$349,336,862	17.1	61,698	\$5,662	191,704	\$1,822
28 FOOT, TOE	\$366,034,033	17.9	61,820	\$5,921	123,588	\$2,962
29 LEG, OTHER	\$86,407,678	4.2	16,049	\$5,384	36,917	\$2,341
6 Other	\$107,047,410	2.3	32,918	\$3,252	60,904	\$1,758
30 SYSTEMWIDE	\$10,334,853	9.7	6,870	\$1,504	11,758	\$879
31 MULTIPLE	\$5,863,802	5.5	1,550	\$3,783	2,261	\$2,593
32 UNSPECIFIED	\$90,848,755	84.9	24,498	\$3,708	46,885	\$1,938

Note:

* Traumatic Brain Injury

6 DISCUSSION

6.1 General

This report established and applied a methodology to calculate the medical burden of mechanical energy injuries among U.S. Army Soldiers. The methodology improves upon past Army injury medical cost estimates (APHC 2020a; Forrest et al. 2021) with the following methodologic enhancements: selection of incident injuries using ICD-10 codes from the Injury Taxonomy, inclusion of lost duty time due to outpatient appointments, and improvements to LDD estimates applied to all injury types.

When calculating costs, LDD estimates significantly impact the resulting indirect cost estimates, given that LDDs contribute 80% or more of the overall cost of injuries. Previous LDD estimates used broad injury categories and ranged from 30 to 120 days, and estimates were not available for all injury types (Ruscio et al. 2010; Hauschild et al. 2018). In this investigation, LDDs were based on weighted averages of LDDs as reported in surveys of over 11,000 U.S. Army Soldiers in operational units (APHC 2018; APHC 2017b; Canham-Chervak et al. 2018), estimates were available for injury types such as MSK tissue damage, and were selected using a conservative approach. With the exception of amputations, all of the LDD estimates used in the current methodology (Table 1) were near or well below the LDDs cited by Ruscio et al. (2010). This is expected, given the surveys represent Soldier reports of LDDs utilized, while the Ruscio et al. (2010) estimates were based on data from orthopedic and sports medical text books that were further validated by a clinical review board. In 2019, the APHC obtained electronic profile (eProfile) data, a U.S. Army administrative system that records injury profile days as recommended by providers and communicated to commanders. With the exception of amputations, all LDD estimates used in the current methodology (Table 1) were near or below the average duration of an injury profile, 2 months (66 LDDs), recorded in eProfile in 2019 (APHC 2021b). Table 10 summarizes recommended adjustments to LDD estimates for consideration in future studies.

Table 10. Recommended Adjustments to LDD Estimates for Future Use in Indirect Cost Estimation of Injuries by Taxonomy Injury Type Categories

Taxonomy Injury Type	Example terms for surveys	LDD Estimate used for Phase 2 indirect cost estimates	Suggested adjustment	Resulting adjusted LDD Estimate for future cost estimation, based on e-Profile estimates when possible (APHC 2021c, unpublished data)
MECHANICAL				
Contusion/Superficial	Abrasion, Bruise, Contusion; Blister	24	Survey data based estimates appear reasonable, adjusted slightly to reflect similar e-Profile estimates	22
Crush	Blunt force trauma; crush/severe pinch	37		30
Dislocation	Dislocation	56		61
Fracture	Fracture; broken bone	63		58
Internal Organ & Blood Vessel	Concussion/brain; injury to chest; abdomen	7	Survey data based estimate appears low for types of injuries included. Adjusted to reflect e-Profile estimates	15
MSK Tissue Damage, Other	Pain; unspecified pain; Bursitis; Fasciitis, Tendonitis, hernia	33	Survey data based estimate appears reasonable, adjusted slightly to reflect similar e-Profile estimates	34
Nerve	Nerve injury/damage	24	Original survey data suggested 59 LDD, and reflected consistencies between three surveys. The LDD estimate was lowered to avoid overestimation, but the higher estimate is consistent with e-Profile estimates	54

Taxonomy Injury Type	Example terms for surveys	LDD Estimate used for Phase 2 indirect cost estimates	Suggested adjustment	Resulting adjusted LDD Estimate for future cost estimation, based on e-Profile estimates when possible (APHC 2021c, unpublished data)
Open Wound	Cut/laceration/puncture	34	Survey data based estimates appear high; adjusted to reflect e-Profile estimates	16
Sprain/Joint Damage	Sprain /tear joint tissue	26	Survey data based estimates appear reasonable, adjusted slightly to reflect similar e-Profile estimates	31
Strain/Tear	Strain/tear (muscle/tendon) (Spasms)	49	Survey data based estimates appear high; adjusted to reflect e-Profile estimates	31
Non-MSK Tissue Damage	Hearing loss	7	Investigators considered estimate low, adjusted to reflect e-Profile estimates.	31
Burn	Burn from fire/electrical	--	Based on prior survey data, LDD not used in current analysis. E-Profile estimates not available.	*14
Amputation	--	365 ^a	Survey data based estimates appear reasonable. E-Profile estimates not available.	365
Multiple injuries/unspecified	To bone/skin/organs form trauma	--	Based on prior survey data, these LDDs were not used in current analysis. E-Profile estimates not available.	*45
Environmental (Heat)	Heat stroke, heat exhaustion, dehydration	--		*24
Environmental (Cold)	Frostbite, hypothermia, chilblains	--		*12
Poisons	Chemicals, Toxins, Drugs	--		*45

Taxonomy Injury Type	Example terms for surveys	LDD Estimate used for Phase 2 indirect cost estimates	Suggested adjustment	Resulting adjusted LDD Estimate for future cost estimation, based on e-Profile estimates when possible (APHC 2021c, unpublished data)
Non-Environmental	Electrical/Radiation	--		*45
OTHER				
Various taxonomy sub categories, <1 % all injuries	Other/Unknown			*45

Notes:

*Indicates new limited duty day (LDD) estimate not used in Phase 2 but derived from SME assessment of LDD survey data (Appendix B).

^a Amputations estimate based on Cross et al. (2011), Stinner et al. (2010), and Tennent et al. (2014).

6.2 Limitations

Cost estimates in this report are underestimates of total injury costs. This investigation focused on mechanical energy injuries, given they represent 97% of all Active Duty Army injuries and costs of non-mechanical energy injuries; other/unspecified injuries (e.g., poisonings, heat/cold injuries, medical accidents) are not included in cost estimates in this report. Survey data (Appendix B) documented LDD estimates for some non-mechanical energy injuries (environmental heat and cold) and other, unspecified, multiple, and unknown injury categories. These LDDs could be applied to estimating costs of non-mechanical energy and other taxonomy energy types (Figure 1). Table 10 shows proposed LDD estimates for these additional non-mechanical energy categories. In addition, as described above, LDD estimates were assigned conservatively since—

- Injuries recorded in diagnostic (DX) positions 2–10 of medical records were not captured;
- Some outpatient surgeries were not included if they were attached to visits preceding the injury diagnosis;
- Other costs such as the time to travel to a clinical visit or the time to fill a prescription were not included; and
- Informal care or care paid by insurers outside the MHS were not included.

Indirect cost associated with lost duty time is likely underestimated because the amount of time scheduled for the appointment was used and not the actual time the Soldier was seen. For these reasons, this methodology yields an overall underestimated (conservative) estimate of the actual costs attributed to Soldiers' injuries.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In 2018, 348,506 AD Army Soldiers received care in the MHS for 791,165 mechanical energy injuries. These injuries represented more than 2.6M encounters and required more than 1.5M hours in outpatient care and 14.8K days of inpatient care. The 791,165 injuries experienced by Army Soldiers in 2018 resulted in \$4.7B in direct and indirect medical costs, when limited duty days are considered 100% limiting.

Indirect costs accounted for the majority of costs for AD Soldiers' injuries (\$4.1B, 88%) due to the estimated days of lost and limited duty and associated loss of productivity. This finding further validates the need to include indirect cost estimates as a part of overall injury costs.

Most of the costs for Soldiers' mechanical energy injuries (\$4.3B, 90.7%) were for MSK injuries, in particular overuse (CMT) MSK injuries. However, the highest cost per injury type and encounter were for acute MSK (Fractures). The two body regions associated with the most injuries—lower extremity and spine/back injuries—were also associated with the majority of cost.

7.2 Recommendations

This methodology, in conjunction with the adjustments to LDD estimates shown in Table 10, should be applied to all Army injuries to demonstrate the magnitude of the injury problem using the metric of U.S dollars (\$). Future verification of the LDD should be conducted by aligning survey injury questions with terms that more clearly map to the established taxonomy injury categories (APHC 2017a, Addendum 1, Tables 1 and 2).

8 POINT OF CONTACT

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APPENDIX A

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APPENDIX B

**Basis for Limited Duty Day (LDD) Estimates for Injury Types
as Defined by the APHC Injury Taxonomy**

Table 3. Distribution Injury Types and Limited Duty Days based on U.S. Army Airborne Division Soldier Survey Responses, 2016*

Characteristic of Injury- Injury Type	Number of Injuries # (%)	Injuries Resulting in Temporary Profile # (%)	Total Limited Duty Days # (%)	Average Number of Limited Duty Days per Injury	<i>Taxonomy injury type categories considered</i>
Sprain or strain	790 (38.4)	480 (34.4)	12,441 (19.9)	25.9	Strain/Tear, Sprain/Joint
Tear muscle/ligaments/meniscus/cartilage	272 (13.2)	216 (15.5)	15,974 (25.6)	73.9	Strain/Tear, Sprain/Joint
Fracture/break	169 (8.2)	153 (10.9)	9,963 (15.9)	65.1	Fracture
Bruise/contusion	75 (3.7)	43 (3.1)	1,085 (1.7)	25.2	Contusion/Superficial
Spinal injury (e.g., bulging or slipped disk)	70 (3.4)	46 (3.3)	2,222 (3.6)	48.3	MSK Tissue, Other
Nerve injury	70 (3.4)	41 (2.9)	2,580 (4.1)	62.9	Nerve
Fasciitis (e.g., plantar fasciitis)	58 (2.8)	40 (2.9)	2,297 (3.7)	57.4	MSK Tissue, Other
Dislocation	56 (2.7)	46 (3.3)	2,215 (3.5)	48.2	Dislocation
Blunt force trauma	51 (2.5)	33 (2.4)	1,385 (2.2)	41.9	Crush
Arthritis	40 (1.9)	29 (2.1)	1,016 (1.6)	35	NOT INJURY
Unspecified pain	32 (1.6)	16 (1.2)	374 (0.6)	23.4	MSK Tissue, Other
Cut/laceration	32 (1.6)	16 (1.2)	651 (1.0)	40.7	Internal Organ & Blood Vessel Contusions/Superficial
Heat injury	26 (1.3)	20 (1.4)	525 (0.8)	26.3	NON-MECHANICAL (Env/Heat)
Bursitis	21 (1.0)	15 (1.1)	213 (0.3)	14.2	MSK Tissue, Other

Characteristic of Injury- Injury Type	Number of Injuries # (%)	Injuries Resulting in Temporary Profile # (%)	Total Limited Duty Days # (%)	Average Number of Limited Duty Days per Injury	<i>Taxonomy injury type categories considered</i>
Abrasion	14 (<1)	5 (0.4)	40 (0.1)	8.0	Contusions/Superficial
Blister	8 (<1)	1 (0.1)	14 (<0.1)	14.0	Non MSK Tissue, Other
Cold injury	4 (<1)	2 (0.1)	44 (0.1)	22.0	NON-MECHANICAL (Env/Heat)
Other	268 (13.0)	192 (13.8)	9,468 (15.2)	49.3	Other/Unspecified/Multiple

Note:

*n=2,056 Soldiers injured (APHC 2018)

Table B-2. Distribution of Injury Types and Limited Duty Days based on U.S. Army 4th Infantry Division Soldier Survey Responses, 2011*

Injury Type	Total injuries # (%)	Medical care sought; temporary profile received # (%)	Total limited work days # (%)	Average limited work days #	<i>Taxonomy injury type categories considered</i>
Strain	219 (25.1)	128 (58.4)	3,700 (18.9)	30	Strain/Tear
Sprain	160 (18.3)	94 (58.8)	2,751 (14.0)	31	Sprain/Joint
Pain	150 (17.2)	71 (47.3)	2,384 (12.1)	35	MSK Tissue, Other
Fracture	76 (8.7)	62 (81.6)	3,373 (17.2)	59	Fracture
Tendonitis or bursitis	34 (3.9)	28 (82.4)	1,083 (5.5)	42	MSK Tissue, Other
Dislocation (joint)	30 (3.4)	19 (63.3)	1,420 (7.2)	84	Dislocation
Nerve injury	28 (3.2)	21 (75.0)	1,108 (5.6)	55	Nerve
Bruise (contusion)	23 (2.6)	19 (82.6)	552 (2.8)	29	Non MSK Tissue
Cut/laceration/ puncture	23 (2.6)	13 (56.5)	249 (1.3)	21	MSK Tissue, Other
Hernia	22 (2.5)	15 (68.2)	532 (2.7)	41	MSK Tissue, Other
Tear	15 (1.7)	14 (93.3)	804 (4.1)	57	Strain/Tear
Scrape/abrasion	11 (1.3)	5 (45.5)	314 (1.6)	63	Contusions/Superficial
Concussion (TBI)	6 (0.7)	3 (50.0)	80 (0.4)	27	Non-MSK Tissue,
Blister	5 (0.6)	0 (-)	0 (-)	-	Non MSK Tissue,
Burn	1 (0.1)	0 (-)	0 (-)	-	Burns
Multiple	4 (0.5)	2 (50.0)	40 (0.2)	20	Other/Unspecified/Multiple
Other	34 (3.9)	24 (70.6)	1,037 (5.3)	49	Other/Unspecified/Multiple
Unspecified	33 (3.8)	11 (33.3)	202 (1.0)	n/a	Other/Unspecified/Multiple

Note:

*n=5,102 Soldiers surveyed; 874 injuries reported (Canham-Chervak et al. 2018)

Table B-3. Distribution Injury Types and Limited Duty Days based on two U.S. Army battalions, 2014-2015*

Injury Type	Total Injuries # (%)	Total Injuries resulting in Temporary Profile # (%)	Total Limited Duty Days # (%)	Average Limited Duty Days per Injury Type #	<i>Taxonomy injury type categories considered</i>
Sprain/Strain	164 (40)	80 (34)	1464 (16)	18	Strain/Tear, Sprain/Joint
Tear	61 (15)	43 (19)	2635 (29)	61	Strain/Tear
Fracture/Break	25 (6)	22 (10)	1609 (18)	73	Fracture
Nerve injury	19 (5)	8 (3)	415 (5)	52	Nerve
Blunt Force/Trauma	15 (4)	12 (5)	282 (3)	24	Crush
Spinal injury	15 (4)	8 (3)	229 (3)	29	MSK Tissue, Other
Unspecified pain	14 (3)	7 (3)	322 (4)	46	MSK Tissue, Other
Bruise/Contusion	13 (3)	3 (1)	50 (<1)	17	Non MSK Tissue; Contusion, Superficial
Arthritis	10 (2)	4 (2)	149 (2)	37	NOT INJURY
Heat injury	8 (2)	3 (1)	34 (<1)	11	NON-MECHANICAL (Env/Heat)
Cut/Laceration	7 (2)	4 (2)	233 (3)	58	Internal Organ & Blood Vessel, Contusions/Superficial
Other/unspecified Overuse	6 (1)	5 (2)	64 (<1)	13	MSK Tissue, Other
Fasciitis	6 (1)	5 (2)	344 (4)	69	MSK Tissue, Other
Dislocation	5 (1)	1 (<1)	35 (<1)	35	Dislocation
Abrasion	5 (1)	3 (1)	34 (<1)	11	Contusions/Superficial
Blister	4 (<1)	1 (<1)	30 (<1)	30	Non MSK Tissue
Bursitis	3 (<1)	2 (<1)	270 (3)	135	MSK Tissue, Other
Tendinitis	3 (<1)	3 (1)	58 (<1)	19	MSK Tissue, Other
Spasms	3 (<1)	1 (<1)	90 (1)	90	MSK Tissue, Other

Injury Type	Total Injuries # (%)	Total Injuries resulting in Temporary Profile # (%)	Total Limited Duty Days # (%)	Average Limited Duty Days per Injury Type #	<i>Taxonomy injury type categories considered</i>
Cold injury	2 (<1)	2 (<1)	5 (<1)	3	NON-MECHANICAL (Env/Heat)
Unknown	9 (2)	4 (2)	179 (2)	45	Other/Unspecified/Multiple
Other	15 (4)	11 (5)	664 (7)	60	Other/Unspecified/Multiple

Note:

*n=813 Soldiers surveyed; 412 injuries reported (APHC 2017b)

Table B-4. Combined Analyses of Survey Injury-Type Limited Duty Day Estimates – Mechanical Injuries

Source	Injury Type	Number of Injuries		Injuries Resulting in Temporary Profile		Total Limited Duty Days		Average Number of Limited Duty Days per Injury w/ a profile
		#	%	#	%	#	%	Average
Abrasion								
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Abrasion	14	0.7	5	0.4	40	0.1	8
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Abrasion	5	1	3	1	34	<1	11
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Scrape/abrasion	11	1.3	5	45.5	314	1.6	63
		30	1	13	1	388	0.4	30
Arthritis								
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Arthritis	40	1.9	29	2.1	1,016	1.6	35
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Arthritis	10	2	4	2	149	2	37
		50	1	33	2	1,165	1	35
Blister								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Blister	5	0.6	0	-	0	-	-
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Blister	8	0.4	1	0.1	14	<1	14
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Blister	4	<1	1	<1	30	<1	30
		17	1	2	0.1	44	0.1	22
Blunt Force Trauma								
Table 4. Distribution (%) of Primary Injury Characteristics and Limited Duty Days (n=2,056 injuries); BLANCHFIELD ARMY COMMUNITY HOSPITAL; U.S. Army Airborne Division Soldiers	Blunt force trauma	51	2.5	33	2.4	1,385	2.2	42
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Blunt Force/Trauma	15	4	12	5	282	3	24
		66	2	45	2	1,667	2	37

Source	Injury Type	Number of Injuries		Injuries Resulting in Temporary Profile		Total Limited Duty Days		Average Number of Limited Duty Days per Injury w/ a profile
		#	%	#	%	#	%	Average
Bruise								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Bruise	23	2.6	19	82.6	552	2.8	29
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Bruise/ contusion	75	3.7	43	3.1	1,085	1.7	25
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Bruise/Contusion	13	3	3	1	50	<1	17
		111	3	65	3	1,687	2	26
Burn								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Burn	1	0.1	0	-	0	-	-
		1	<1	0	0	0	0	0
Bursitis								
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Bursitis	21	1.0	15	1.1	213	0.3	14
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Bursitis	3	<1	2	<1	270	3	135
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Tendonitis	3	<1	3	1	58	<1	19
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Tendonitis or bursitis	34	3.9	28	82.4	1,083	5.5	42
		61	2	48	2	1,624	2	34
Concussion (TBI)								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Concussion (TBI)	6	0.7	3	50	80	0.4	27
		6	0.2	3	0.1	80	0.1	27
Cut/Laceration								
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Cut/laceration	32	1.6	16	1.2	651	1.0	41

Source	Injury Type	Number of Injuries		Injuries Resulting in Temporary Profile		Total Limited Duty Days		Average Number of Limited Duty Days per Injury w/ a profile
		#	%	#	%	#	%	Average
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Cut/Laceration	7	2	4	2	233	3	58
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Cut/laceration/puncture	23	2.6	13	56.5	249	1.3	21
		62	2	33	2	1,133	1	34
Dislocation								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Dislocation	30	3.4	19	63.3	1,420	7.2	84
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Dislocation	56	2.7	46	3.3	2,215	3.5	48
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Dislocation	5	1	1	<1	35	<1	35
		91	3	66	3	3,670	4	56
Fasciitis								
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Fasciitis	6	1	5	2	344	4	69
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Fasciitis	58	2.8	40	2.9	2,297	3.7	57
		64	2	45	2	2,641	3	59
Fracture								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Fracture	76	8.7	62	81.6	3,373	17.2	59
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Fracture/break	169	8.2	153	10.9	9,963	15.9	65
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Fracture/Break	25	6	22	10	1609	18	73
		270	8	237	11	14,945	16	63
Hernia								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et	Hernia	22	2.5	15	68.2	532	2.7	41

Source	Injury Type	Number of Injuries		Injuries Resulting in Temporary Profile		Total Limited Duty Days		Average Number of Limited Duty Days per Injury w/ a profile
		#	%	#	%	#	%	Average
al. 2018. Surveys of 4ID Soldiers (n=5,102).								
		22	1	15	1	532	1	35
Nerve injury								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Nerve injury	28	3.2	21	75	1,108	5.6	55
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Nerve injury	70	3.4	41	2.9	2,580	4.1	63
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Nerve injury	19	5	8	3	415	5	52
		117	4	70	3	4,103	4	59
Pain								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Pain	150	17.2	71	47.3	2,384	12.1	35
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Unspecified pain	32	1.6	16	1.2	374	0.6	23
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Unspecified pain	14	3	7	3	322	4	46
		196	6	94	4	3,080	3	33
Spasms								
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Spasms	3	<1	1	<1	90	1	90
		3	0.1	1	0.1	90	0.1	90
Spinal injury								
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Spinal injury	15	4	8	3	229	3	29
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Spinal injury	70	3.4	46	3.3	2,222	3.6	48
		85	3	54	3	2,451	3	45
Sprain or Strain								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Sprain	160	18.3	94	58.8	2,751	14	31

Source	Injury Type	Number of Injuries		Injuries Resulting in Temporary Profile		Total Limited Duty Days		Average Number of Limited Duty Days per Injury w/ a profile
		#	%	#	%	#	%	Average
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Strain	219	25.1	128	58.4	3,700	18.9	30
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Sprain or strain	790	38.4	480	34.4	12,441	19.9	26
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Sprain/Strain	164	40	80	34	1464	16	18
		1,333	40	782	36	20,356	22	26
Tear								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Tear	15	1.7	14	93.3	804	4.1	57
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Tear	61	15	43	19	2635	29	61
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Tear	272	13.23	216	15.49	15,974	25.6	74
		348	10	273	13	19,413	21	71

Table B-5. Combined Analyses of Survey Injury-Type Limited Duty Day Estimates – Non-Mechanical – Environmental Injuries

Source	Injury Type	Number of Injuries		Injuries Resulting in Temporary Profile		Total Limited Duty Days		Average Number of Limited Duty Days per Injury w/ a profile
		#	%	#	%	#	%	Average
Cold Injury								
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Cold injury	4	0.2	2	0.1	44	0.1	22
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Cold injury	2	<1	2	<1	5	<1	3
		6	0.2	4	0.2	49	0.1	12
Heat Injury								
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Heat injury	26	1.3	20	1.4	525	0.8	26
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Heat injury	8	2	3	1	34	<1	11
		34	1	23	1	559	1	24

Table B-6. Combined Analyses of Survey Injury-Type Limited Duty Day Estimates – Multiple, Other, and Unspecified Injuries

Source	Injury Type	Number of Injuries		Injuries Resulting in Temporary Profile		Total Limited Duty Days		Average Number of Limited Duty Days per Injury w/ a profile
		#	%	#	%	#	%	Average
Multiple								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Multiple	4	0.5	2	.5	40	0.2	20
		4	0.1	2	0.1	40	<1	20
Other								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Other	34	3.9	24	70.6	1,037	5.3	49
U.S. Army Airborne Division Soldiers, BLANCHFIELD ARMY COMMUNITY HOSPITAL; (n=2,056 injuries)	Other	268	13.0	192	13.8	9,468	15.2	49
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Other	15	4	11	5	664	7	60
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Other/unspecified Overuse	6	1	5	2	64	<1	13
		323	10	232	11	11,233	12	48
Unknown								
Technical Report No. S.0030637-17, Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat	Unknown	9	2	4	2	179	2	45
		9	0.3	4	0.2	179	0.2	45
Unspecified								
Distribution of Injury Types and Limited Work Days among Infantry Brigade Soldiers; Canham-Chervak et al. 2018. Surveys of 4ID Soldiers (n=5,102).	Unspecified	33	3.8	11	33.3	202	1	-
		33	1	11	0.5	202	0.2	18

APPENDIX C

Differences in the Cost Calculated for Limited Duty Days (LDD): Taxonomy 60-Day Gap Incidence Rule (New Rule) versus the Traditional DX1 60-Day Gap Incidence Rule

Results reported in this report used the following parameters:

- The traditional 60-day incidence rule based on DX1 was used to determine the number of injuries.
- A 60-day incidence rule (new rule) based on the APHC injury taxonomy variables 'injury type' and 'body region 2' was applied to estimate which injuries (based on DX1) incurred limited duty days.

The tables in this Appendix demonstrates differences in the cost calculated for LDD using the taxonomy 60-Day gap incidence rule as applied in this effort versus the DX1 60-Day gap incidence rule. Table C-1 compares example lower extremity diagnoses, while Tables C-2 and C-3 demonstrate the different cost estimates resulting from the two approaches for different sub-categories of mechanical energy injuries (ACT and CMT, both MSK and non-MSK). Table C-4 provides the resulting different cost estimates. Tables C-5 and C-6 show costs for each method by anatomical site/body region, and Table C-7 shows the final differences.

Overall, the use of the taxonomy-based incidence rule, which takes into account the anatomical location and types of injuries, avoids overestimation of injuries (and costs) for certain types of 'incident injuries' that are assigned different diagnosis.

Table C-1. Examples: Comparison of Limited Duty Days Assigned to Injuries: Taxonomy 60-Day Gap Incidence Rule and the DX1 60-Day Gap Incidence Rule

Pseudo ID (Soldier)	Encounter Date	Dx1	Taxonomy 60-Day Gap Incidence Rule (new)*	DX1 60-Day Gap Incidence Rule (previous)*	Dx1 Def	Body Region B	Injury Type A	Injury Type B	Taxonomy LDDs	DX1 LDDs
2BE3F1F39	12/1/2017	M25552	1	1	Pain in left hip	Hip	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	33	33
2BE3F1F39	12/6/2017	M25552	0	0	Pain in left hip	Hip	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
2BE3F1F39	12/6/2017	M7650	1	1	Patellar tendinitis, unspecified knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	33	33
2BE3F1F39	12/12/2017	M25562	0	1	Pain in left knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	33
1C561B124	9/14/2017	S92001A	1	1	Unspecified fracture of right calcaneus, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	63	63
1C561B124	9/14/2017	S92041A	0	1	Displaced other fracture of tuberosity of right calcaneus, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1C561B124	9/14/2017	S92251A	0	1	Displaced fracture of navicular (scaphoid) of right foot, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1C561B124	9/14/2017	S92331A	0	1	Displaced fracture of third metatarsal bone, right foot, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1C561B124	9/14/2017	S92341A	0	1	Displaced fracture of fourth metatarsal bone, right foot,	Foot, toe	FRACTURE	Acute, MSK	0	63

Pseudo ID (Soldier)	Encounter Date	Dx1	Taxonomy 60-Day Gap Incidence Rule (new)*	Dx1 60-Day Gap Incidence Rule (previous)*	Dx1 Def	Body Region B	Injury Type A	Injury Type B	Taxonomy LDDs	Dx1 LDDs
					initial encounter for closed fracture					
1C561B124	9/14/2017	M79604	1	1	Pain in right leg	Leg, Other	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	33	33
1C561B124	9/15/2017	S92241A	0	1	Displaced fracture of medial cuneiform of right foot, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1C561B124	9/15/2017	S92251A	0	0	Displaced fracture of navicular (scaphoid) of right foot, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	0
1C561B124	9/21/2017	S92011A	0	1	Displaced fracture of body of right calcaneus, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1C561B124	9/22/2017	S92301A	0	1	Fracture of unspecified metatarsal bone(s), right foot, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1C561B124	9/25/2017	S92011A	0	0	Displaced fracture of body of right calcaneus, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	0
1C561B124	9/28/2017	S92011A	0	0	Displaced fracture of body of right calcaneus, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	0

Pseudo ID (Soldier)	Encounter Date	Dx1	Taxonomy 60-Day Gap Incidence Rule (new)*	Dx1 60-Day Gap Incidence Rule (previous)*	Dx1 Def	Body Region B	Injury Type A	Injury Type B	Taxonomy LDDs	Dx1 LDDs
1C561B124	10/2/2017	S92021A	0	1	Displaced fracture of anterior process of right calcaneus, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1C561B124	10/2/2017	S92251A	0	0	Displaced fracture of navicular (scaphoid) of right foot, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	0
1C561B124	10/3/2017	S92251A	0	0	Displaced fracture of navicular (scaphoid) of right foot, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	0
1A190DDA2	6/21/2017	M79672	1	1	Pain in left foot	Foot, toe	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	33	33
1A190DDA2	6/22/2017	M25572	1	1	Pain in left ankle and joints of left foot	Ankle	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	33	33
1A190DDA2	6/22/2017	S92422A	1	1	Displaced fracture of distal phalanx of left great toe, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	63	63
1A190DDA2	6/23/2017	S92425A	0	1	Nondisplaced fracture of distal phalanx of left great toe, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	63
1A190DDA2	7/7/2017	S92425A	0	0	Nondisplaced fracture of distal phalanx of left great toe, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	0

Pseudo ID (Soldier)	Encounter Date	Dx1	Taxonomy 60-Day Gap Incidence Rule (new)*	Dx1 60-Day Gap Incidence Rule (previous)*	Dx1 Def	Body Region B	Injury Type A	Injury Type B	Taxonomy LDDs	Dx1 LDDs
1A190DDA2	8/2/2017	S92425A	0	0	Nondisplaced fracture of distal phalanx of left great toe, initial encounter for closed fracture	Foot, toe	FRACTURE	Acute, MSK	0	0
1A190DDA2	8/4/2017	M79672	0	0	Pain in left foot	Foot, toe	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A190DDA2	8/7/2017	M79672	0	0	Pain in left foot	Foot, toe	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A190DDA2	8/9/2017	M79672	0	0	Pain in left foot	Foot, toe	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A18745E0	2/13/2017	M25561	1	1	Pain in right knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	33	33
1A18745E0	2/16/2017	M25561	0	0	Pain in right knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A18745E0	3/23/2017	M25561	0	0	Pain in right knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A18745E0	4/3/2017	M23331	1	1	Other meniscus derangements, other medial meniscus, right knee	Knee	SPRAIN/JOINT DAMAGE	Acute, MSK	26	26
1A18745E0	4/27/2017	S83241A	0	1	Other tear of medial meniscus, current injury, right knee, initial encounter	Knee	SPRAIN/JOINT DAMAGE	Acute, MSK	0	26
1A18745E0	6/9/2017	M25561	1	1	Pain in right knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	33	33
1A18745E0	6/29/2017	M25561	0	0	Pain in right knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A18745E0	7/7/2017	M25561	0	0	Pain in right knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A18745E0	8/1/2017	M25562	0	1	Pain in left knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	33
1A18745E0	8/7/2017	M25562	0	0	Pain in left knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0

Pseudo ID (Soldier)	Encounter Date	Dx1	Taxonomy 60-Day Gap Incidence Rule (new)*	Dx1 60-Day Gap Incidence Rule (previous)*	Dx1 Def	Body Region B	Injury Type A	Injury Type B	Taxonomy LDDs	Dx1 LDDs
1A18745E0	9/6/2017	M25562	0	0	Pain in left knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
1A18745E0	10/4/2017	M25562	0	0	Pain in left knee	Knee	MSK TISSUE DAMAGE, OTHER	Cumulative, MSK	0	0
Review Case Total			10	22					383	1042

Note:

* "1" indicates limited duty days should be added to the entry; "0" indicates limited duty days should not be added to the entry.

Table C-2. Cost of Lower Body Injuries by Taxonomy Subcategory Using Traditional DX1 Incidence Rule, All AD Soldiers, CY 2017

Type	Total People	Total Injuries*	Total Encounters	Outpatient Appointment Time (Hour)	Bed Days	Direct Medical Cost	Indirect Cost - Lost Duty	Indirect Cost - Limited Duty	Total Cost	Limited Duty Days
Acute, Non-MSK	16,621	18,249	21,653	18,411	410	\$7,085,754	\$866,300	\$56,446,860	\$63,157,778	362,571
Cumulative, Non-MSK	16,283	20,358	44,594	22,887	96	\$10,181,266	\$990,728	\$80,667,475	\$87,285,448	488,592
Acute, MSK	51,976	69,664	104,121	77,617	2,800	\$66,097,699	\$3,876,385	\$407,850,432	\$454,639,638	2,595,073
Cumulative, MSK	250,086	492,397	1,546,966	810,860	1,257	\$239,866,444	\$33,959,934	\$2,721,801,165	\$2,848,019,403	16,331,589
Total	†275,331	600,668	1,717,334	929,775	4,563	\$323,231,163	\$39,693,347	\$3,266,765,932	\$3,453,102,267	19,777,825

Notes:

* 60-day gap incidence rule based on Dx1

† Total number of people with >1 injury of any type

Table C-3. Cost of Lower Body Injuries by Taxonomy Subcategory Using the APHC Taxonomy Incidence Rule (New Rule), AD Soldiers, CY 2017

Type	Total People	Total Injuries*	Total Encounters	Outpatient Appointment Time (Hour)	Bed Days	Direct Medical Cost	Indirect Cost - Lost Duty	Indirect Cost - Limited Duty	Total Cost	Limited Duty Days
Acute, Non-MSK	16,621	17,451	21,653	18,411	410	\$7,085,754	\$866,300	\$53,412,646	\$59,575,699	343,196
Cumulative, Non-MSK	16,283	18,537	44,594	22,887	96	\$10,181,266	\$990,728	\$72,936,427	\$78,739,876	444,888
Acute, MSK	51,976	58,665	104,121	77,617	2,800	\$66,097,699	\$3,876,385	\$337,098,084	\$370,194,371	2,152,536
Cumulative, MSK	250,086	412,180	1,546,966	810,860	1,257	\$239,866,444	\$33,959,934	\$2,278,643,870	\$2,376,885,339	13,660,640
Total	†275,331	506,833	1,717,334	929,775	4,563	\$323,231,163	\$39,693,347	\$2,742,091,027	\$2,885,395,285	16,601,260

Notes:

* A 60-day gap incidence rule based on DX1 and the APHC injury taxonomy variables 'injury type' and 'body region 2' was applied

† Total number of people with >1 injury of any type

Table C-4. Difference between Two Incidence Rule Methods: Traditional DX1 Method (Table C-2) and Taxonomy Method (Table C-3)

	Total People	Total Injuries	Total Encounters	Outpatient Appointment Time (Hour)	Bed Days	Direct Medical Cost	Indirect Cost - Lost Duty	Indirect Cost - Limited Duty	Total Cost	Limited Duty Days
Acute, Non- MSK	0	798	0	0	0	\$0	\$0	\$3,034,214	\$3,582,079	19,375
Cumulative, Non-MSK	0	1,821	0	0	0	\$0	\$0	\$7,731,048	\$8,545,572	43,704
Acute, MSK	0	10,999	0	0	0	\$0	\$0	\$70,752,348	\$84,445,267	442,537
Cumulative, MSK	0	80,217	0	0	0	\$0	\$0	\$443,157,295	\$471,134,064	2,670,949
Total Difference	0	93,835	0	0	0	\$0	\$0	\$524,674,905	\$567,706,982	3,176,565

Table C-5. Cost of Lower Body Injuries by Body Region Using Traditional DX1 Incidence Rule, AD Soldiers, CY 2017

	Total People	Total Injuries*	Total Encounters	Outpatient Appointment Time (Hour)	Bed Days	Direct Medical Cost	Indirect Cost - Lost Duty	Indirect Cost - Limited Duty	Total Cost	Limited Duty Days
Leg, Upper	11,402	13,239	23,193	12,843	502	\$6,743,694	\$662,023	\$76,387,657	\$80,833,274	516,075
Leg, Other	14,004	17,180	32,545	16,499	35	\$5,500,282	\$653,048	\$88,030,064	\$91,872,319	566,940
Leg, Lower	37,607	49,703	91,027	49,678	804	\$21,358,337	\$2,183,098	\$262,239,568	\$277,810,663	1,743,383
Foot, Toe	53,940	74,519	127,355	64,054	337	\$27,574,374	\$2,773,528	\$422,422,165	\$441,466,134	2,520,382
Hip	37,392	57,715	186,285	96,330	437	\$39,030,198	\$3,924,949	\$296,383,923	\$318,412,859	1,891,855
Ankle	52,520	74,436	192,735	103,425	578	\$34,105,507	\$4,329,177	\$382,690,645	\$403,527,372	2,395,702
Knee	91,394	154,994	462,962	248,915	714	\$89,190,527	\$10,104,962	\$819,266,932	\$871,445,808	5,017,674
Back, Lower	103,442	158,882	601,232	338,030	1155	\$99,728,244	\$15,062,561	\$919,344,978	\$967,733,838	5,125,814
Total	†275,331	600,668	1,717,334	929,774	4,562	\$323,231,163	\$39,693,346	\$3,266,765,932	\$3,453,102,267	19,777,825

Notes:

* 60-day incidence rule based on Dx1

† Total number of people with >1 injury of any type

Table C-6. Cost of Lower Body Injuries by Body Region; using Taxonomy Incidence Rule; AD Soldiers, CY 2017

	Total People	Total Injuries*	Total Encounters	Outpatient Appointment Time (Hour)	Bed Days	Direct Medical Cost	Indirect Cost - Lost Duty	Indirect Cost - Limited Duty	Total Cost	Limited Duty Days
Leg, Upper	11,402	12,275	23,193	12,843	502	\$6,743,694	\$662,023	\$70,188,960	\$73,832,071	473,568
Leg, Other	14,004	15,128	32,545	16,499	35	\$5,500,282	\$653,048	\$77,568,860	\$80,871,990	499,224
Leg, Lower	37,607	42,856	91,027	49,678	804	\$21,358,337	\$2,183,098	\$221,470,951	\$233,839,246	1,468,144
Foot, Toe	53,940	64,161	127,355	64,054	337	\$27,574,374	\$2,773,528	\$357,505,899	\$373,253,063	2,135,280
Hip	37,392	45,856	186,285	96,330	437	\$39,030,198	\$3,924,949	\$235,391,655	\$250,695,679	1,499,060
Ankle	52,520	65,367	192,735	103,425	578	\$34,105,507	\$4,329,177	\$333,730,808	\$350,197,844	2,092,679
Knee	91,394	118,512	462,962	248,915	714	\$89,190,527	\$10,104,962	\$622,004,774	\$659,201,467	3,834,288
Back, Lower	103,442	142,678	601,232	338,030	1155	\$99,728,244	\$15,062,561	\$824,229,119	\$863,503,923	4,599,017
Total	†275,331	506,833	1,717,334	929,774	4,562	\$323,231,163	\$39,693,346	\$2,742,091,026	\$2,885,395,283	16,601,260

Notes:

* A 60-day gap incidence rule based on DX1 and the APHC injury taxonomy variables 'injury type' and 'body region 2' was applied

† Total number of people with >1 injury in any body region

Table C-7. Body Region Cost Differences using Two Incidence Rule Methods: Traditional DX1 (Table C-5) and Taxonomy (Table C-6)

	Total People†	Total Injuries*	Total Encounters	Outpatient Appointment Time (Hour)	Bed Days	Direct Medical Cost	Indirect Cost - Lost Duty	Indirect Cost - Limited Duty	Total Cost	Limited Duty Days
Leg, Upper	0	964	0	0	0	\$0	\$0	\$6,198,697	\$7,001,203	42,507
Leg, Other	0	2,052	0	0	0	\$0	\$0	\$10,461,204	\$11,000,329	67,716
Leg, Lower	0	6,847	0	0	0	\$0	\$0	\$40,768,617	\$43,971,417	275,239
Foot, Toe	0	10,358	0	0	0	\$0	\$0	\$64,916,266	\$68,213,071	385,102
Hip	0	11,859	0	0	0	\$0	\$0	\$60,992,268	\$67,717,180	392,795
Ankle	0	9,069	0	0	0	\$0	\$0	\$48,959,837	\$53,329,528	303,023
Knee	0	36,482	0	0	0	\$0	\$0	\$197,262,158	\$212,244,341	1,183,386
Back, Lower	0	16,204	0	0	0	\$0	\$0	\$95,115,859	\$104,229,915	526,797
Difference	0	93,835	0	0	0	\$0	\$0	\$524,674,906	\$567,706,984	3,176,565

Notes:

† Total number of people with >1 injury in any body region

* A 60-day gap incidence rule based on DX1 and the APHC injury taxonomy variables 'injury type' and 'body region 2' was applied

APPENDIX D

Distribution of Cost Estimates When Duty Limitation is at 50%

Table D-1. Distribution of Medical Costs, Mechanical Energy Injuries by Body System where Duty Limitations were 50%, AD Soldiers, CY 2018

Body System	Total Cost		Direct Medical Cost		Indirect Cost - Lost Duty		Indirect Cost - Limited Duty)	
	N	% All	N	% All	N	% All	N	% All
	\$2,680,304,332	100	\$570,759,713	21.3	\$67,145,876	2.5	\$2,042,398,743	76.2
All NON-MSK	\$259,048,298	9.7	\$72,045,319	12.6	\$8,790,473	13.1	\$178,212,506	8.7
ACUTE, NON-MSK	\$162,192,792	62.6	\$47,278,037	65.6	\$6,009,351	68.4	\$108,905,404	61.1
OVERUSE, NON-MSK	\$96,855,506	38.0	\$24,767,282	34.4	\$2,781,122	31.6	\$69,307,102	38.9
All MSK	\$2,421,256,034	90.3	\$498,714,394	87.4	\$58,355,403	86.9	\$1,864,186,237	91.3
ACUTE, MSK	\$416,064,062	17.2	\$125,745,893	25.2	\$7,294,718	12.5	\$283,023,451	15.2
OVERUSE, MSK	\$2,005,191,972	82.8	\$372,968,501	74.8	\$51,060,685	87.5	\$1,581,162,786	84.8

Table D-2. Estimates of Medical Costs for Mechanical Energy Injuries Resulting in Medical Encounters, by Body System where Duty Limitations were 50%, AD Soldiers, CY 2018

Body System	Total cost		Total Injuries		Total Encounters	
	N	% All	N	Cost per Injury	N	Cost per Encounter
	\$2,680,304,332	100	791,165	\$3,388	2,586,773	\$1,036
All NON-MSK	\$259,048,298	9.7	115,811	\$2,237	206,011	\$1,257
ACUTE, NON-MSK	\$162,192,792	62.0	70,216	\$2,310	104,176	\$1,557
OVERUSE, NON-MSK	\$96,855,506	38.0	45,595	\$2,124	101,835	\$951
All MSK	\$2,421,256,034	90.3	675,354	\$3,585	2,380,762	\$1,017
ACUTE, MSK	\$416,064,062	16.30	88,537	\$4,699	164,077	\$2,536
OVERUSE, MSK	\$2,005,191,972	82.8	586,817	\$3,417	2,216,685	\$905

Table D-3. Distribution of Medical Costs of Mechanical Energy Injuries Resulting in Medical Encounters by Body Region and Anatomical Site where Duty Limitations were 50%, AD Soldiers, CY 2018

Body Region Anatomical Site	Total cost		Direct Medical Cost		Indirect Cost – Lost Duty		Indirect Cost – Limited Duty	
	N	%	N	%	N	%	N	%
	\$2,680,304,332	100	\$570,759,713	21.3	\$67,145,876	2.5	\$2,042,398,743	76.2
1 Head & Neck	\$93,975,732	3.2	\$32,888,064	5.8	\$4,242,663	6.3	\$56,845,005	2.8
01 TBI	\$15,760,997	12.8	\$11,007,932	33.5	\$1,180,989	27.8	\$3,572,076	6.3
02 OTHER HEAD	\$60,915	0.1	\$40,136	0.1	\$4,680	0.1	\$16,099	0.0
03 FACE	\$13,144,715	14.0	\$4,809,738	14.6	\$410,885	9.7	\$7,924,092	13.9
04 EYE	\$12,823,465	14.9	\$2,873,970	8.7	\$360,338	8.5	\$9,589,157	16.9
05 EAR	\$20,805,980	22.5	\$6,692,732	20.4	\$1,065,993	25.1	\$13,047,255	23.0
06 NECK	\$14,491,122	17.6	\$2,098,461	6.4	\$346,475	8.2	\$12,046,186	21.2
07 HEAD/NECK OTHER	\$16,888,539	18.3	\$5,365,095	16.3	\$873,303	20.6	\$10,650,141	18.7
2 Spine & Back	\$714,832,076	27.1	\$131,599,587	23.1	\$18,380,131	27.4	\$564,852,358	27.7
08 BACK, UPPER	\$140,010,827	19.5	\$27,262,101	20.7	\$3,544,606	19.3	\$109,204,120	19.3
09 BACK, MIDDLE	\$40,471,775	5.8	\$5,954,780	4.5	\$763,065	4.2	\$33,753,930	6.0
10 BACK, LOWER	\$480,156,649	66.8	\$92,707,613	70.4	\$13,336,396	72.6	\$374,112,640	66.2
11 BACK, OTHER	\$54,192,825	8.0	\$5,675,093	4.3	\$736,064	4.0	\$47,781,668	8.5
3 Torso	\$35,591,816	1.3	\$10,199,005	1.8	\$1,091,861	1.6	\$24,300,950	1.2
12 CHEST	\$20,283,966	58.9	\$4,741,717	46.5	\$538,002	49.3	\$15,004,247	61.7
13 ABDOMEN	\$4,856,260	13.3	\$1,565,922	15.4	\$167,916	15.4	\$3,122,422	12.8
14 PELVIS	\$9,928,848	26.9	\$3,417,140	33.5	\$354,557	32.5	\$6,157,151	25.3
15 TRUNK, OTHER	\$522,742	0.9	\$474,226	4.6	\$31,386	2.9	\$17,130	0.1

Body Region Anatomical Site	Total cost		Direct Medical Cost		Indirect Cost – Lost Duty		Indirect Cost – Limited Duty	
	N	%	N	%	N	%	N	%
	\$2,680,304,332	100	\$570,759,713	21.3	\$67,145,876	2.5	\$2,042,398,743	76.2
4 Upper Extremity	\$618,266,195	22.8	\$142,474,701	25.0	\$15,294,551	22.8	\$460,496,943	22.5
16 SHOULDER	\$300,889,384	47.6	\$80,081,199	56.2	\$8,421,401	55.1	\$212,386,784	46.1
17 ARM, UPPER	\$17,826,824	2.8	\$5,423,906	3.8	\$309,546	2.0	\$12,093,372	2.6
18 ELBOW	\$59,444,879	9.8	\$11,493,596	8.1	\$1,615,976	10.6	\$46,335,307	10.1
19 ARM, LOWER	\$22,971,519	3.6	\$6,907,113	4.8	\$526,189	3.4	\$15,538,217	3.4
20 WRIST	\$84,040,265	14.0	\$15,615,544	11.0	\$1,804,166	11.8	\$66,620,555	14.5
21 HAND, FINGER	\$120,260,969	20.1	\$21,496,371	15.1	\$2,383,800	15.6	\$96,380,798	20.9
22 ARM, OTHER	\$12,832,356	2.2	\$1,456,972	1.0	\$233,473	1.5	\$11,141,911	2.4
5 Lower Extremity	\$1,145,228,067	43.3	\$219,809,737	38.5	\$24,497,675	36.5	\$900,920,655	44.1
23 HIP	\$154,227,964	13.1	\$36,054,477	16.4	\$3,932,262	16.1	\$114,241,225	12.7
24 LEG, UPPER	\$55,547,736	4.9	\$9,526,775	4.3	\$907,084	3.7	\$45,113,877	5.0
25 KNEE	\$381,870,075	32.6	\$86,080,039	39.2	\$9,638,902	39.3	\$286,151,134	31.8
26 LEG, LOWER	\$114,667,488	10.1	\$20,879,106	9.5	\$2,126,755	8.7	\$91,661,627	10.2
27 ANKLE	\$193,716,816	17.1	\$33,200,836	15.1	\$4,485,597	18.3	\$156,030,383	17.3
28 FOOT, TOE	\$198,462,934	17.9	\$27,821,921	12.7	\$2,679,317	10.9	\$167,961,696	18.6
29 LEG, OTHER	\$46,735,055	4.2	\$6,246,583	2.8	\$727,758	3.0	\$39,760,714	4.4
6 Other	\$72,410,447	2.3	\$33,788,619	5.90	\$3,638,995	5.4	\$34,982,833	1.7
30 SYSTEMWIDE	\$10,181,191	9.7	\$8,811,794	26.1	\$1,083,693	29.8	\$285,704	0.8
31 MULTIPLE	\$5,268,078	5.5	\$4,472,765	13.2	\$113,005	3.1	\$682,308	2.0
32 UNSPECIFIED	\$56,961,178	84.9	\$20,504,060	60.7	\$2,442,297	67.1	\$34,014,821	97.2

Table D-4. Estimates of Medical Costs, Mechanical Energy Injuries Resulting in Medical Encounters by Body Region and Anatomical Site where Duty Limitations were 50%, AD Soldiers, CY 2018

Body Region Anatomical Site	Total cost		Total Injuries		Total Encounters	
	N	%	N	Cost per Injury	N	Cost per Encounter
	\$2,680,304,332	100	791,165	\$3,388	2,586,773	\$1,036
1 Head & Neck	\$93,975,732	3.2	44,493	\$2,112	70,053	\$1,341
01 TBI	\$15,760,997	12.8	5,030	\$3,133	9,705	\$1,624
02 OTHER HEAD	\$60,915	0.1	77	\$791	130	\$469
03 FACE	\$13,144,715	14.0	3,011	\$4,366	4,940	\$2,661
04 EYE	\$12,823,465	14.9	5,526	\$2,321	8,517	\$1,506
05 EAR	\$20,805,980	22.5	17,993	\$1,156	27,723	\$750
06 NECK	\$14,491,122	17.6	4,323	\$3,352	5,879	\$2,465
07 HEAD/NECK OTHER	\$16,888,539	18.3	8,533	\$1,979	13,159	\$1,283
2 Spine & Back	\$714,832,076	27.1	195,068	\$3,665	752,641	\$950
08 BACK, UPPER	\$140,010,827	19.5	36,026	\$3,886	142,445	\$983
09 BACK, MIDDLE	\$40,471,775	5.8	11,659	\$3,471	30,032	\$1,348
10 BACK, LOWER	\$480,156,649	66.8	130,201	\$3,688	546,208	\$879
11 BACK, OTHER	\$54,192,825	8.0	17,182	\$3,154	33,956	\$1,596
3 Torso	\$35,591,816	1.3	10,651	\$3,342	16,543	\$2,151
12 CHEST	\$20,283,966	58.9	6,195	\$3,274	9,828	\$2,064
13 ABDOMEN	\$4,856,260	13.3	1,537	\$3,160	2,331	\$2,083
14 PELVIS	\$9,928,848	26.9	2,853	\$3,480	4,290	\$2,314
15 TRUNK, OTHER	\$522,742	0.9	66	\$7,920	94	\$5,561

Body Region Anatomical Site	Total cost		Total Injuries		Total Encounters	
	N	%	N	Cost per Injury	N	Cost per Encounter
	\$2,680,304,332	100	791,165	\$3,388	2,586,773	\$1,036
4 Upper Extremity	\$618,266,195	22.8	159,749	\$3,870	585,829	\$1,055
16 SHOULDER	\$300,889,384	47.6	72,331	\$4,160	364,385	\$826
17 ARM, UPPER	\$17,826,824	2.8	3,631	\$4,910	6,895	\$2,585
18 ELBOW	\$59,444,879	9.8	16,315	\$3,644	57,875	\$1,027
19 ARM, LOWER	\$22,971,519	3.6	7,340	\$3,130	12,338	\$1,862
20 WRIST	\$84,040,265	14.0	24,382	\$3,447	70,436	\$1,193
21 HAND, FINGER	\$120,260,969	20.1	31,840	\$3,777	64,735	\$1,858
22 ARM, OTHER	\$12,832,356	2.2	3,910	\$3,282	9,165	\$1,400
5 Lower Extremity	\$1,145,228,067	43.3	348,286	\$3,288	1,100,803	\$1,040
23 HIP	\$154,227,964	13.1	45,219	\$3,411	190,439	\$810
24 LEG, UPPER	\$55,547,736	4.9	16,310	\$3,406	31,774	\$1,748
25 KNEE	\$381,870,075	32.6	110,623	\$3,452	444,239	\$860
26 LEG, LOWER	\$114,667,488	10.1	36,567	\$3,136	82,142	\$1,396
27 ANKLE	\$193,716,816	17.1	61,698	\$3,140	191,704	\$1,010
28 FOOT, TOE	\$198,462,934	17.9	61,820	\$3,210	123,588	\$1,606
29 LEG, OTHER	\$46,735,055	4.2	16,049	\$2,912	36,917	\$1,266
6 Other	\$72,410,447	2.3	32,918	\$2,200	60,904	\$1,189
30 SYSTEMWIDE	\$10,181,191	9.7	6,870	\$1,482	11,758	\$866
31 MULTIPLE	\$5,268,078	5.5	1,550	\$3,399	2,261	\$2,330
32 UNSPECIFIED	\$56,961,178	84.9	24,498	\$2,325	46,885	\$1,215