Identification of work-related injury emergency department visits using International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes

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ABSTRACT

Introduction Emergency department (ED) visit discharge data are a less explored population-based data source used to identify work-related injuries. When using discharge data, work-relatedness is often determined by the expected payer of workers' compensation (WC). In October 2015, healthcare discharge data coding systems transitioned to the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). ICD-10-CM's structure offers potential new work-related codes to enhance work-related injury surveillance. This study identified work-related ED visits using relevant ICD-10-CM work-related injury codes. Cases identified using this method were compared with those identified using the WC expected payer approach.

Methods State ED visit discharge data (2016–2019) were analysed using the CDC's discharge data surveillance definition. Injuries were identified using a diagnosis code or an external cause-of-injury code in any field. Injuries were assessed by mechanism and expected payer. Literature searches and manual review of ICD-10-CM codes were conducted to identify possible work-related injury codes. Descriptive statistics were performed and assessed by expected payer.

Results WC was billed for 87 361 injury ED visits from 2016 to 2019. Falls were the most frequent injury mechanism. The 246 ICD-10-CM work-related codes identified 36% more work-related ED injury visits than using WC as the expected payer alone.

Conclusion This study identified potential ICD-10-CM codes to expand occupational injury surveillance using discharge data beyond the traditional WC expected payer approach. Further studies are needed to validate the work-related injury codes and support the development of a work-related injury surveillance case definition.

INTRODUCTION

Research and epidemiological studies on occupational injuries in the USA rely heavily on the use of various secondary data sources.[1] There is no single comprehensive data source of worker injuries, and traditional sources (eg, workers' compensation (WC) claims and Bureau of Labor Statistics reports) often underestimate the burden and scope of work-related injuries because they capture only severe injuries, rely on self-reports and exclude certain work establishments (eg, small farms) and the self-employed.[2–4] Statewide population-level hospital discharge data are also increasingly utilised in the prevention and control of occupational injuries.[5]

Despite not being designed for occupational injury surveillance, discharge data such as emergency department (ED) visits can potentially provide information on work-related injuries. With the ED visit data, work-relatedness is often determined by filtering by expected payer of WC, a suitable proxy for work-relatedness.[5–9] The Council of State and Territorial Epidemiologists and researchers use WC payer as a proxy for occupational health indicators and work-related injuries requiring medical care.[6 7 9 10] However, this method underestimates work-related injuries, often only capturing more severe injuries—the portion requiring medical treatment.[10] The National Hospital Ambulatory Medical Surveys, a nationally representative ED visit dataset, found 40% of work-related ED visits were paid by non-workers' compensation (non-WC) sources.[10] To overcome the limitations of solely using WC as expected payer to identify work-related injuries, several studies have explored using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) external cause codes with discharge data to identify causes of workplace injuries.[6 7]

Healthcare and hospitals transitioned discharge data coding systems from ICD-9-CM to ICD Tenth Revision, Clinical Modification (ICD-10-CM) codes in October 2015, expanding coding specificity and structure.[11–15] The coding transitioned from a primary axis of nature of injury (ICD-9-CM) to the primary axis of body region (ICD-10-CM), expanding to more than 43 000 injury diagnosis codes in ICD-10-CM, compared with 2600 codes under ICD-9-CM.[13] The external causes of morbidity that provide details on the injury mechanism (eg, fall, motor vehicle crash, drug poisoning), intention (unintentional, intentional or undetermined), place of occurrence, activity at time of injury (eg, dancing) and employment status (eg, military, civilian), increased from 1300 codes in ICD-9-CM to 7500 in ICD-10-CM.[13] These codes are important for population-based injury surveillance; however, they are not required for discharge billing reimbursement.[16] Other important coding structure changes that affect injury surveillance due to the transition are described elsewhere.[11 13–15 17]

The new coding system enhanced the potential identification of work-related injuries through

expansion of possible work-related ICD-10-CM codes. For example, traffic-related injury codes in ICD-9-CM provided limited information regarding the injury event (eg, E10.0, motor vehicle traffic collision with train injuring driver of motor vehicle other than motorcycle). The ICD-10-CM coding system allows for expanded detail regarding the traffic-related injury and circumstances (eg, V65.5, driver of heavy transport vehicle (tractor-trailer) injured in traffic collision with railway train or vehicle). The possible impact of the ICD-10-CM coding transition on the identification of work-related injuries remains mostly unexamined.

This study's objectives were to (1) examine work-related injuries by expected payer, (2) identify possible work-related injuries using ICD-10-CM codes through published literature and manual reviews and (3) assess the change in capture of work-related injuries via the ICD-10-CM work-related injury codes compared with the traditional WC expected payer approach alone.

METHODS
Study data

Data for this study were obtained from the Kentucky outpatient services database in the Office of Health Data and Analytics at the Kentucky Cabinet for Health and Family Services. Records were deidentified per state data agreements and reflected ED encounters of care rather than unique numbers of individuals receiving care for an injury. Calendar year was based on date of discharge. Records were not limited by patient state of residence for better approximation of resident and non-resident work-related injuries. This study was approved by the University of Kentucky Institutional Review Board. Analyses were conducted using SAS V.9.4 (SAS Institute Inc, Cary, North Carolina, USA).

ICD-10-CM ED visit records

Injury-related ED visits were identified from records with a discharge date of 1 January 2016, to 31 December 2019, guided by CDC's 2017 proposed surveillance case definition for injury ED visits.[18] Only initial encounters were included (a seventh character of 'A' or missing) in the ED dataset using a diagnosis code of S00–S99, T07–T34, T36–T50 with a sixth character of 1, 2, 3 or 4; T36.9, T37.9, T39.9, T41.4, T42.7, T43.9, T45.9, T47.9 and T49.9 with a fifth character of 1, 2, 3 or 4; T51–T65, T66–T76, T79; or an external cause-of-injury code of V00–V99, W00–X58, X71–X83, X92–Y09, Y21–Y33 or Y35–Y38.[18] Subsequent and sequelae visits were omitted.

The CDC ICD-10-CM external cause-of-injury matrix was used to categorise the injury visit by mechanism of injury.[11] The completeness of cause-of-injury coding was 86.9%. Injury mechanisms were filtered by expected payer. All ED visits had at least one payer listed; 78.8% had only one payer; 19.4% had two; and 1.9% had three. Expected payer was subdivided into two groups—WC payer and non-WC payer. When more than one expected payer was listed, an 'any mention' approach was used to classify visits as WC or non-WC payer. The distribution for WC as an expected payer was 98.1% using the first payer field (85 674 visits), 1.4% using the second (1244 visits) and 0.5% using the third (443 visits).

To identify a subset of ICD-10-CM external causes of morbidity that might be work-related, two research team members (ML and AMB) manually assessed all possible ICD-10-CM external cause of morbidity codes for likelihood of being work-related. Each team member independently assessed the codes and then shared results. If there was disagreement, the third research

Table 1 ICD-10-CM ED injury visits*, injury mechanism by expected payer, Kentucky 2016–2019

Mechanism of injury†	ED injury visits	Expected payer	
		WC (%)	Non-WC (%)
Cut/pierce	132 715	12 263 (9.4)	120 452 (90.8)
Drowning/submersion	444	1 (0.2)	443 (99.8)
Fall	616 713	17 878 (2.9)	598 835 (97.1)
Fire/burn	22 982	2116 (9.2)	20 866 (90.8)
Firearm	4654	43 (0.9)	4611 (99.1)
Machinery	11 849	3492 (29.5)	8357 (70.5)
All transportation	286 098	6556 (2.3)	279 542 (97.7)
Motor vehicle traffic crash	232 260	5293 (2.3)	226 967 (97.7)
Non-traffic	21 838	555 (2.5)	21 283 (97.5)
Pedal cyclist	8746	21 (0.2)	8725 (99.8)
Pedestrian	3152	170 (5.4)	2982 (94.6)
Other transport	20 102	517 (2.6)	19 585 (97.4)
Nature/environment	94 076	2302 (2.5)	91 774 (97.6)
Overexertion	110 015	8410 (7.6)	101 605 (92.4)
Poisoning	62 909	975 (1.5)	61 934 (98.5)
Drug-related	52 327	250 (0.5)	52 077 (99.5)
Non-drug-related	10 582	725 (6.9)	9857 (93.2)
Struck by/against	268 673	16 092 (6.0)	252 581 (94.0)
Suffocation	1535	6 (0.4)	1529 (99.6)
Other specified	89 334	5490 (6.2)	83 844 (93.9)
Unspecified	168 990	5685 (3.4)	163 305 (96.6)
Not elsewhere classified	7215	264 (3.7)	6951 (93.3)
Undetermined mechanism‡	182 534	5788 (3.2)	176 746 (96.8)
Total	2 060 736	87 361 (4.2)	1 973 375 (95.8)

*ED visits represent encounters of care and could be greater than the number of individual patients treated.
†Mechanism of injury codes are cited elsewhere.[11]
‡Undetermined mechanism includes injury encounters without sufficient documentation to determine mechanism.
ED, emergency department; ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification; WC, workers' compensation.

team member (TLB) weighed in on the work-related codes in question. External causes of morbidity for legal intervention (Y35), supplementary factors (Y90–Y98), external cause status (Y99) and other injury events that were likely work-related were included (online supplemental appendix A).

The completeness of coding among all injury visits (n=2 060 736) was 1.9% (39 281 visits: 59.0% WC, 41.0% non-WC) for a work-related employment status code, 0.2% (4305 visits: 7.7% WC, 92.3% non-WC) for a work-related activity code and 0.9% (19 131 visits: 48.5% WC, 51.5% non-WC) for a work-related place of occurrence code. The coding completeness was 3.1% for the entire ED visit discharge dataset having at least one work-related code (63 459 visits: 50.5% WC, 49.5% non-WC). Work-related injuries identified by external causes of morbidity were not mutually exclusive.

RESULTS

Based on ICD-10-CM case selection criteria, there were 2 060 736 injury visits treated in Kentucky ED facilities from 2016 to 2019. WC was included as an expected payer for 87 361 visits (4.2%, table 1). Falls were the most frequent injury mechanism (29.9%). The mechanism with the highest proportion of injury ED visits with an expected payer of WC was machinery (29.5%). Among injury ED visits with WC as the expected payer, the most common mechanisms were fall (20.5%), struck by/against (18.4%) and cut/pierce (14.0%) injuries.

The research team identified 246 ICD-10-CM codes as possibly work-related (online supplemental appendix A); the

Table 2 ICD-10-CM ED injury visits* with work-related external cause of morbidity codes, by expected payer, Kentucky 2016–2019

External cause of morbidity code groups†	ED injury visits	Expected payer WC (%)	Non-WC (%)
Transportation	1940	711 (36.7)	1229 (63.4)
Driver of heavy transport vehicle injured in transport injury	1026	416 (40.6)	610 (59.5)
Bus driver injured in transport injury	290	91 (31.4)	199 (68.6)
Other land transport injury	625	204 (32.6)	421 (67.4)
Water transportation injury	0	0 (N/A)	0 (N/A)
Air and space transport injury	0	0 (N/A)	0 (N/A)
Exposure to force	2644	740 (28.0)	1904 (72.0)
Fall from scaffolding	310	73 (23.6)	237 (76.5)
Exposure to inanimate mechanical forces	1823	509 (27.9)	1314 (72.1)
Exposure to electric current, radiation, and extreme ambient air temperature and pressure	472	147 (31.1)	325 (68.9)
Other and unspecified effects and factors‡	39	11 (28.2)	28 (71.8)
Legal intervention, war and military operations	570	305 (53.5)	265 (46.5)
Place of occurrence	19 131	9278 (48.5)	9853 (51.5)
Industrial premise	17 026	9086 (53.4)	7940 (46.6)
Farm or slaughterhouse	2105	192 (9.1)	1913 (90.9)
Military base or training grounds	238	16 (6.7)	222 (93.3)
Activity	4305	333 (7.7)	3972 (92.3)
Animal care, shearing, milking	98	9 (9.2)	89 (90.9)
Building and grounds care	4184	324 (7.7)	3860 (92.3)
Other, refereeing	23	0 (0.0)	23 (100.0)
Employment status	39 281	23 162 (59.0)	16 119 (41.0)
Civilian activity done for income or pay	39 098	23 146 (59.2)	15 952 (40.8)
Military activity	183	16 (8.7)	167 (91.3)
Any work-related external cause code	63 459	32 024 (50.5)	31 435 (49.5)
No work-related external cause code	1 997 277	55 337 (2.8)	1 941 940 (97.3)
Total	2 060 736	87 361 (4.2)	1 973 375 (95.8)

*ED visits represent encounters of care and could be greater than the number of individual patients treated.
†A visit may have multiple external cause of morbidity codes; a full list of these possible work-related codes can be found in online supplemental appendix A.
‡Other and unspecified effects and factors include other and unspecified effects of external causes, contact with heat and hot substances, and exposure to other specified factors.
ED, emergency department; WC, workers' compensation.

majority related to legal intervention, operations of war, military operations and terrorism (50.0%) and transportation (37.0%).

ICD-10-CM codes identified 63 459 work-related ED injury visits regardless of expected payer (table 2). Among ED injury visits with a work-related code, regardless of expected payer, employment status (61.9%) and place of occurrence (30.1%) identified most of the work-related injuries. Of these, the most reported employment status and place of occurrence codes were civilian employment status (civilian activity done for income or pay, 61.6%) and injuries on an industrial premise (26.8%).

Over a third (36.7%) of ED visits with WC as expected payer had a work-related external cause code (32 024 visits). Civilian employment status (72.3%) was the most common work-related code observed among WC expected payer ED visits having any work-related code (n=32 024). ED visits with a work-related code indicating civilian employment status (59.2%) and legal intervention, war and military operations (53.5%) had the highest proportion of visits with WC as the expected payer.

Almost half (49.5%) of the injury ED visits with any ICD-10-CM work-related external cause code had non-WC as the expected payer. Civilian employment status was the most common (50.7%) work-related code observed among ED visits with non-WC as expected payer and any work-related code (n=31 435). ED visits with a work-related code indicating

refereeing activity (100%) and place of occurrence at a military base or training grounds (93.3%) had the highest proportion of visits with non-WC as the expected payer.

ICD-10-CM work-related external causes of morbidity captured 36.0% more work-related injury visits than using WC expected payer alone (118 796 visits and 87 361, respectively, table 3).

DISCUSSION

This study assessed the combination of the traditional WC expected payer and external cause of morbidity codes in the ICD-10-CM coding system to identify work-related injuries. WC was the expected payer at a similar proportion in ICD-9-CM data (data not shown) and in other published studies.[19] Falls were the most frequent injury mechanism among all ED visits (not just those that were work-related), including those with expected WC coverage, a finding consistent with other studies of work-related ED visits.[20 21] Contact with machinery injuries had the highest proportion of expected WC coverage, similar to other studies.[6 19 20 22]

Only 8% of the injury ED visits with expected WC coverage were due to overexertion, under-representing the burden of work-related overexertion injuries requiring emergency care, as

Discharge data coding system	Visits identified using expected payer of WC	Visits identified by presence of work-related codes among visits with expected payer of non-WC	All work-related ED visits (either criteria)	Percent increase† in identification of work-related ED visits
ICD-10-CM	87 361	31 435	118 796	36.0

*ED visits represent encounters of care and could be greater than the number of individual patients treated.
†Percent increase is the difference in the number of work-related visits identified when using WC payer versus non-WC and a work-related external cause code.
ED, emergency department; ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification; WC, workers' compensation.

there were no overexertion injury mechanism codes in the first year of ICD-10-CM implementation.[11] The first ICD-10-CM overexertion code (X50) went into effect in late 2016, with additional ICD-10-CM overexertion codes (X50.0, X50.1, X50.3 and X50.9) being added in 2019.[11] As a result, actual overexertion injury-related ED visits were quantified by other injury mechanisms, resulting in undercounting.

This study identified 246 ICD-10-CM external cause of morbidity codes to characterise work-related injuries requiring emergency care or treatment. The majority of the work-related codes pertained to legal intervention and enhanced transportation. ICD-10-CM legal intervention codes specify the injured individual and injury mechanism, such as a law enforcement official injured during a legal intervention involving manhandling (Y35.811), an opportunity not previously offered under ICD-9-CM.[23] The work-related transportation codes (eg, driver of heavy transport vehicle injured in collision with pedestrian or animal (V61.0)) offer an occupational epidemiology tool to identify high-risk worker populations and exposures and inform occupational injury prevention opportunities (eg, collaborations with Federal Motor Carrier Safety Administration and Offices of Highway Safety on a truck driver sharing-the-road campaign).

The incorporation of external causes of morbidity allowed for enhanced identification of work-related visits. The majority of injury ED visits with work-related codes were identified by the civilian employment status and place of occurrence codes, increasing the identification of work-relatedness compared with WC expected payer alone. Fifty-one percent of non-WC visits with a work-related code were identified via a civilian employment status. Moreover, the majority of injury ED visits noting military employment status had an expected payer of non-WC, suggesting WC alone is not optimum in identifying military work-related injuries. Injuries occurring on military bases were most often identified among ED injury visits with non-WC expected coverage.

Utilising multiple external causes of morbidity to assess work-related injuries may inform injury prevention planning programmes as well as workplace safety standards and regulations. This could prove particularly useful in identifying injuries among workers not typically covered by WC (eg, self-employed, contractors and temporary workers). For example, one in two legal intervention injuries had WC coverage, suggesting that not all law enforcement personnel are covered under WC insurance. This is expected, as law enforcement may not be employed directly by state and local government but contracted as civilian employees without employer-sponsored health insurance coverage. Utilising ICD-10-CM codes indicating injury to a law enforcement official in conjunction with the civilian employment status code may offer further insight and clarification. Additionally, activity codes, such as injuries while refereeing, bring awareness to injuries in an understudied worker population. No refereeing injuries were covered by WC, a finding consistent with their independent contractor status.

Few studies have used ED data to examine work-related injuries[19–21]; most utilise hospitalisation data with the WC payer and some external cause codes.[6 8] This study is among the first to demonstrate the utility of external causes of morbidity in identifying possible work-related injuries. Our results show that combining WC charged injury visits with respective ICD-10-CM external cause of morbidity codes enhanced the capture of work-related ED visits by 36.0% over the use of WC expected payer alone. Future studies are needed to estimate the positive predictive value of these codes to capture work-related injuries treated in EDs, especially as WC expected payer is a good indicator of work-relatedness and just over one-third of expected WC injury visits had a possible work-related code.[5–9]

The inclusion of ICD-10-CM non-external cause of morbidity codes Z04.2 (encounter for examination and observation following work accident) and Z57 (occupational exposure to risk factors) warrant further consideration; this study assessed external cause of morbidity codes only. Utilisation of Z codes may provide the reasoning for seeking ED treatment. Examination of Z codes allowed for the identification of possible work-related injury ED visits that would not have been identified by WC expected payer or a work-related external cause code. Specifically, 30% of the 91 visits with a Z04.2 code and 22% of the 176 visits with a Z57 code were not identified by WC expected payer or a work-related code.

As most of the work-related ED visits in this study were identified by the use of employment status and place of occurrence codes, it is important to note that these external cause of morbidity codes are not required for reimbursement by Centers for Medicare and Medicaid Services or Kentucky statutes; ICD-10-CM coding mandates vary by state. The usefulness of external cause of morbidity codes is limited by the documentation of occupational information by healthcare practitioners. A sample of medical records from 12 EDs in one state reported 98% ICD-9-CM completion and cause of injury accuracy was 65% and 57% for work-related and non-work-related cases, respectively; only 30% of all cases had completed place of occurrence codes[22]; medical record reviews are yet to be performed on work-related ICD-10-CM cases. Clinicians are encouraged to document adequate injury details (eg, mechanism, intent, location and preceding activity) in the medical record for accurate ICD-10-CM coding of the ED encounter by medical coders. The Council of State and Territorial Epidemiologists is encouraged to work with medical and professional associations to develop and deliver continuing education and training to raise awareness about the important role that health practitioners serve in work-related injury surveillance and prevention. Suggested training topics range from injury documentation and data entry to quality and completeness of population-based surveillance. Healthcare providers are integral for the accurate assignment by medical coders of ICD-10-CM work-related injuries seen in the ED.

Assessing work-related injuries through the use of the primary WC payer field alone suggests an undercount of work-related ED visits.[24] This study utilised all three available expected payer fields to identify work-related injuries and examined expected payer using a WC 'any mention' approach to expand accurate identification of work-related injury ED visits. The any mention of WC approach allowed 2% more work-related injuries to be identified. Follow-up studies on actual payment are needed.

Employing a combined WC expected payer and work-related code approach in this study provided expanded identification of possible work-related injuries treated in the ED. With expanded ICD-10-CM codes now available in the ED visit dataset, the ED visit dataset should be an integral data source that supplements employer reports (eg, WC claims, Bureau of Labor Statistic reports) in worker injury surveillance. As alternative contractor relationships that do not provide WC coverage are increasing,[25] quantifying work-related injuries through supplemental data sources, such as ED data, is of utmost importance for accurate occupational injury surveillance. The expanded ICD-10-CM work-related external cause codes enhance occupational injury surveillance of non-traditional workers, such as migrant, self-employed, farm, temporary and uninsured workers.

LIMITATIONS
This study reports only on work-related injuries, not work-related illnesses. Future work should assess the potential utility of ICD-10-CM codes to capture work-related illnesses, such as silicosis, in ED discharge data.[26] Another limitation is that the data in this study represent the number of ED visits as opposed to individual injuries. Our state data policies require discharge data to be deidentified. As work-related injury visits presented in this study may have multiple external cause codes, work-related injury visits in this study are subject to potential misclassification and under-reporting or over-reporting, as the two approaches are not mutually exclusive. Studies are warranted to confirm the sensitivity and specificity of the

external cause of morbidity codes in identifying work-related injuries. This study uses secondary data, utilising ICD coding systems designed for healthcare billing reimbursements. External causes of morbidity are not required for ED discharge purposes, and, as a result, completion may vary across facilities and jurisdictions.[16] Future studies should assess the quality and completeness of work-related ICD-10-CM external cause of morbidity codes.

Conclusion
The work-related ICD-10-CM codes identified in this study allow for enhanced surveillance of occupational injuries not captured using only WC as the expected payer. As hospitals and healthcare facilities adopted ICD coding for discharge purposes and not injury surveillance purposes, work-related injuries can be better identified using the combined expected payer and external cause code approach based on the results of this study. The unique structure of ICD-10-CM permits the addition of more external cause codes in the future to enhance identification of work-related injuries in population-based discharge datasets.

What is already known on this subject?

► Workers' compensation (WC) claims and labour statistics surveys are frequently used to identify worker injuries, but often underestimate the work-related injury burden. Work-related injuries are not exclusively captured by one data source. Previous research examining discharge data (emergency department (ED) visits) have often identified work-related injuries using the WC expected payer approach. Data coded using the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) coding system has been less explored for occupational injury surveillance.

What this study adds?

► The WC expected payer approach in combination with work-related codes expand the utility of discharge data for population-based occupational injury surveillance. This study identifies 246 potential work-related ICD-10-CM codes. Use of these codes provides an opportunity to identify and assess worker injuries not covered by WC.

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