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Exploring injury intentionality and mechanism via ICD-10-CM injury codes and self-reported injury in a large, urban emergency department

Michael J Clery ,^{1,2} Philip Joseph Hudson ,³ Jasmine C Moore,²
Laura M Mercer Kollar ,⁴ Daniel T Wu^{1,2}

¹Department of Emergency Medicine, School of Medicine, Emory University, Atlanta, Georgia, USA

²Grady Health System, Atlanta, Georgia, USA

³Injury Prevention Program, Georgia Department of Public Health, Atlanta, Georgia, USA

⁴Division of Violence Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, Georgia, USA

Correspondence to

Dr Michael J Clery, Department of Emergency Medicine, Emory University School of Medicine, Atlanta 30322, Georgia, USA; michael.j.clery@emory.edu

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ABSTRACT

Health systems capture injuries using International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Clinical Modification (ICD-10-CM) diagnostic codes and share data with public health to inform injury surveillance. This study analyses provider-assigned ICD-10-CM injury codes among self-reported injuries to determine the effectiveness of ICD-10-CM coding in capturing injury and assault.

Methods Self-reported injury screen records from an urban, level 1 trauma centre collected between 20 November 2015 and 30 September 2019 were compared with corresponding provider-assigned ICD-10-CM codes discerning the frequency in which intentions are indicated among patients reporting (1) any injury and (2) assault.

Results Of 380 922 patients screened, 32 788 (8.61%) reported any injury and 6763 (1.78%) reported assault. ICD-10-CM codes had a sensitivity of 67.40% (95% CI 66.89% to 67.91%) for any injury and specificity of 89.79% (95% CI 89.69% to 89.89%). For assault, ICD-10-CM codes had sensitivity of 2.25% (95% CI 1.91% to 2.63%) and specificity of 99.97% (95% CI 99.97% to 99.98%).

Discussion This study found provider-assigned ICD-10-CM had limited sensitivity to identify injury and low sensitivity for assault. This study more fully characterises ICD-10-CM coding system effectiveness in identifying assaults.

codes.⁷ The degree to which these ICD-10-CM external cause codes are reliably used in clinical practice to identify intentional injury is unclear.

This study provides insight into a population identified through a violence prevention effort that specifically and prospectively identifies victims of assault or interpersonal violence, rather than relying on external cause codes to identify mechanism and intent. While one may infer a stab wound or gunshot wound results from violence, a diagnosis of ‘head injury’ could result from a motor vehicle crash, a sports injury or a physical assault. This study analyses ICD-10-CM injury codes in patients with a self-reported injury screener to determine the effectiveness of provider-assigned ICD-10-CM coding in capturing injury intentionality.

METHODS

Patients presenting to the ED of a large, Southeastern US urban hospital were screened for intentional injuries. The ED is located at a designated level I trauma centre with an annual census of over 150 000 patient visits per year. Approximately 70%–86% of ED patients were screened by a nurse verbally asking the patient questions relating to injury and interpersonal violence as part of the Cardiff Violence Prevention Model, a violence prevention programme.⁸ Answers were recorded in the electronic medical record.

The dataset consisted of 380 922 ED records for adult patients who were screened at triage between 20 November 2015 and 30 September 2019. Data included demographics (age, race and sex), responses to the injury screener and provider-assigned ICD-10-CM codes.⁸ Providers, including residents, nurse practitioners, physician assistants and attending physicians, assigned final diagnosis ICD-10-CM code(s) for each patient at the end of the patient’s encounter.

The injury screen contains two questions analysed here: ‘were you injured?’ and ‘was someone trying to hurt you?’ Records were identified as containing a self-reported injury if ‘yes’ was answered for the first question and as assault or interpersonal violence cases if they answered ‘yes’ to both. To identify cases coded for injury and assault using ICD-10-CM diagnostic codes, every ICD-10-CM code assigned to each record was scanned for any relevant injury diagnosis codes (table 1). Records were identified as an assault if they contained any assault codes from the ICD-10-CM.⁹ Using self-reported injury and assault as reference standards, sensitivity and specificity were calculated for ICD-10-CM codes capturing injury and assault

INTRODUCTION

Violent injury is a leading cause of morbidity and mortality in the USA.¹ Among African American adolescents, homicide is the leading cause of death¹; and for every homicide there are 94 non-fatal violent injuries.² A majority of the violent injuries treated in the emergency department (ED) are not reported to law enforcement.^{3,4}

Injury surveillance describes the relative magnitude of injury type, monitors trends in injuries, identifies new injury burdens and evaluates prevention and intervention efforts; injury surveillance data are subsequently used to inform research and intervention.⁵ Healthcare providers are required to use the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Clinical Modification (ICD-10-CM) to report medical data to the US Department of Health and Human Services.⁶

A recent study evaluating the impact of the transition from ICD-9-CM to ICD-10-CM confirmed the increased specificity of ICD-10-CM by decreasing the use of codes with undetermined intent and increased identification of assaults based on injury



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Table 1 ICD-10-CM codes used to identify emergency department records coded for injury and assault

ICD-10-CM codes	Definitions
Injury*	
All S codes	Anatomic injuries
T07–T34	Foreign bodies, burns, corrosions, frostbite
T66–T76	Other and unspecified effects of external causes (radiation, heat, light, hypothermia, hyperthermia, asphyxiation, child and adult abuse, lightning, drowning, motion sickness, etc)
T79	Certain early complications of trauma, not elsewhere classified
O9A.2–O9A.5	Injury, poisoning and certain other consequences of external causes; and physical, sexual and psychological abuse complicating pregnancy, childbirth and the puerperium
T84.04	Periprosthetic fracture around internal prosthetic joint
M97	Periprosthetic fracture around internal prosthetic joint
Assault	
X92–Y09	Intentional injury inflicted by another person, by any mechanism.

*Source: Injury codes and definitions from Hedegaard and Johnson (2019), Table C, excluding codes T36–T65 related to drug overdose and non-drug poisoning. ICD-10-CM, International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Clinical Modification.

respectively in the provider-coded electronic health records. Data analysis was conducted using SAS V.9.4.

Neither patients or the public were involved in the design, conduct, reporting or dissemination plans of our research.

RESULT

In the 380 922 records examined, 32 788 (8.61%) patients self-reported any injury and a subset of 6763 (1.78%) reported assault. Additionally, by ICD-10-CM code identification, 57 656 (15.14%) injury cases and 258 (0.07%) assault cases were identified. Patients were predominantly non-Hispanic black (76.9%; n=2 92 875) and male (57%; n=2 17 905); see [table 2](#).

[Table 3](#) contains the sensitivity, specificity and predictive values of both injury and assault in ICD-10-CM codes. For any injury, ICD-10-CM codes had a sensitivity of 67.40% (95% CI 66.89% to 67.91%) and specificity of 89.79% (95% CI 89.69% to 89.89%). Positive predictive value was 38.3% (95% CI 37.93% to 38.73%) and negative predictive value was 96.69% (95% CI 96.63% to 96.75%). For assault, ICD-10-CM codes had a sensitivity of 2.25% (95% CI 1.91% to 2.63%) and specificity of 99.97% (95% CI 99.97% to 99.98%). Positive predictive value was 58.91% (95% CI 52.64% to 64.98%) and negative predictive value was 98.26% (95% CI 98.22% to 98.30%).

Table 2 Characteristics of the study population

Characteristics	All records reviewed (n=380 922)
Age	
Mean (SD)	47.62 (16.24)
Missing/unknown, n (%)	320 (0.08)
Race/ethnicity, n (%)	
White, non-Hispanic	35 760 (9.39)
Black, non-Hispanic	292 875 (76.89)
Hispanic	34 812 (9.14)
Asian	2227 (0.58)
NHOPI	155 (0.04)
AIAN	711 (0.19)
Multiracial	1155 (0.30)
Other	2083 (0.55)
Missing or unknown	11 144 (2.93)
Gender, n (%)	
Male	217 905 (57.20)
Female	162 778 (42.73)
Missing/unknown	239 (0.06)

AIAN, American Indian/Alaska Native; NHOPI, Native Hawaiian or Other Pacific Islander.

to 38.73%) and negative predictive value was 96.69% (95% CI 96.63% to 96.75%). For assault, ICD-10-CM codes had a sensitivity of 2.25% (95% CI 1.91% to 2.63%) and specificity of 99.97% (95% CI 99.97% to 99.98%). Positive predictive value was 58.91% (95% CI 52.64% to 64.98%) and negative predictive value was 98.26% (95% CI 98.22% to 98.30%).

Both self-report (screener) and ICD-10-CM codes identified injury and violence, and 22 099 records were identified by both methods, 35 557 were identified via ICD-10-CM code alone and 10 689 were identified by injury screener alone. There were distinct instances where an injury was only found via one method. The top 10 primary diagnosis codes were reviewed ([table 4](#)). The top primary diagnoses in cases identified only by ICD-10-CM code were S-codes (eg, injury) with many related to injuries to the head (eg, open wound of head, superficial injury of head), whereas the top diagnoses for cases identified via the

Table 3 Case counts with sensitivity and specificity for ICD-10-CM reporting of injury and assault, compared with the injury screener as a reference standard, with exact 95% CIs

	Injury screener Cases (n)	Injury screener Non-cases (n)	Total	Results
Injury				
ICD-10-CM Cases (n)	22 099	35 557	57 656	Positive predictive value (%) 38.33 (95% CI 37.93 to 38.73)
ICD-10-CM Non-cases (n)	10 689	312 577	323 266	Negative predictive value (%) 96.69 (95% CI 96.63 to 96.75)
Total	32 788	348 134	380 922	
Results	Sensitivity (%) 67.40 (95% CI 66.89 to 67.91)	Specificity (%) 89.79 (95% CI 89.69 to 89.89)		
Assault				
ICD-10-CM Cases (n)	152	106	258	Positive predictive value (%) 58.91 (95% CI 52.64 to 64.98)
ICD-10-CM Non-cases (n)	6611	374 053	380 664	Negative predictive value (%) 98.26 (95% CI 98.22 to 98.30)
Total	6763	374 159	380 922	
Results	Sensitivity (%) 2.25 (95% CI 1.91 to 2.63)	Specificity (%) 99.97 (95% CI 99.97 to 99.98)		

ICD-10-CM, International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Clinical Modification.

Table 4 Leading primary diagnosis codes among injury cases captured by only one tool

ICD-10-CM only (n=35 557)			Injury screener only (n=10 689)		
Primary DX	Definition	n (%)	Primary DX	Definition	n (%)
S01	Open wound of head	2028 (5.7)	M25	Other joint disorder, not elsewhere classified	2125 (19.88)
S00	Superficial injury of head	1308 (3.68)	M54	Dorsalgia	1984 (18.56)
S61	Open wound of wrist, hand and fingers	1214 (3.41)	M79	Other and unspecified soft tissue disorders, not elsewhere classified	1060 (9.92)
S16	Injury of muscle, fascia and tendon at neck level	1204 (3.39)	R07	Pain in throat and chest	548 (5.13)
S82	Fracture of patella	1202 (3.38)	R51	Headache	445 (4.16)
S39	Other and unspecified injuries of abdomen, lower back, pelvis and external genitals	1143 (3.21)	Z04	Encounter for examination or observation for other reasons	240 (2.25)
S02	Fracture of skull and facial bones	928 (2.61)	R10	Abdominal and pelvic pain	238 (2.23)
S06	Concussion	911 (2.56)	F10	Alcohol-related disorders	221 (2.07)
S62	Fracture of navicular bone of wrist	807 (2.27)	R55	Syncope and collapse	191 (1.79)
S09	Other and unspecified injuries of head	772 (2.17)	G40	Epilepsy and recurrent seizures	113 (1.06)

ICD-10-CM, International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Clinical Modification.

injury screener alone contained a variety of codes from other ICD-10-CM chapters largely related to pain in a region of the body instead of an injury.

DISCUSSION

Provider-assigned ICD-10-CM codes did not reliably identify injuries and assaults that were self-reported in an ED screen. Although specificity was high for ICD-10-CM codes to identify injury, the sensitivity was less than 70% despite injury codes identifying almost twice the number of encounters for injury as those actually self-reported (15.14% and 8.61%, respectively). Based on this analysis, both ICD-10-CM codes and self-report have overlap and complement each other with additional identification of injury. For surveillance purposes, this is a concern because certain types of injuries are then likely to be systematically overlooked and trends that may reflect risks to public health may not be detectable if relying exclusively on one method.

Assault was poorly identified by provider-assigned ICD-10-CM external cause codes, which had only a 2.25% sensitivity for self-reported assault injury. This demonstrates a severe barrier to identification and monitoring of the violent injury burden and raises concern for underestimation of incidence and prevalence. Intentionality components of injury codes may be even more frequently included in this analysis than in typical practice of injury surveillance by public health entities as it included not only the primary diagnosis code, but all ICD-10-CM codes associated with the encounter. Future research may consider examining the differences in sensitivity when performed by professional coders as compared with provider coded records.

This study has several limitations as this was performed at a single, urban, level 1 trauma-designated centre and may not reflect the broader injury and assault trends across the nation. Also, providers assigned diagnostic codes rather than using medical coding services. We expect this may limit the number of diagnoses applied given only one code is required to complete the patient encounter and additional time is required to record qualifiers associated with a diagnosis. The implications would be better understood with broader study of how ICD-10-CM codes are assigned beyond this single centre. Nurses are trained to request violent injury information and patients only reveal information they feel comfortable sharing. Increased nurse refresher training on the screen may be needed to improve mechanism

reporting. More exploration of patient perceptions of the screen and hesitancy to report intentionality or mechanism could be a focus of future research.

Despite these limitations, these data show high specificity and negative predictive values for injury and assault. More work is needed to understand what factors most affect sensitivity such as who assigns codes (provider or medical coding service), coding practices and training for ICD-10-CM. If high specificity can be maintained and sensitivity significantly increased, ICD-10-CM codes may provide important surveillance information for injury and assault patterns.

CONCLUSION

In this study, provider-assigned ICD-10-CM codes and self-reported injury both demonstrated gaps in surveillance. Improvements are needed in implementation of ICD-10-CM use, especially to improve their reliability for assault injuries. Injury surveillance methods should seek to improve ICD-10-CM use and explore additional measures for the identification and trending of violence and injuries for population health.

What is already known on the subject

- ▶ International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Clinical Modification health system data are reported to the US Department of Health and Human Services.
- ▶ Data are used for injury and violence surveillance.

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What this study adds

- ▶ Characterises the effectiveness of provider-assigned International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Clinical Modification (ICD-10-CM) codes in capturing injury and interpersonal violence experiences relative to self-reported injury and interpersonal violence.
- ▶ Provides preliminary evidence that more complete use of ICD-10-CM codes is needed to accurately reflect injury and interpersonal violence experiences.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This study was determined exempt by the Emory Institutional Review Board (IRB00115147).

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ORCID iDs

Michael J Clery <http://orcid.org/0000-0002-1701-1289>

Philip Joseph Hudson <http://orcid.org/0000-0002-2958-8181>

Laura M Mercer Kollar <http://orcid.org/0000-0001-9517-7690>

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