INPLASY

Validity and reliability of external cause injury International Classification of Diseases, Tenth Revision (ICD-10) codes: a systematic review

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ADMINISTRATIVE INFORMATION

INTRODUCTION

Review question / Objective This systematic review is examining the following research question for populations of all ages in all countries: what is the validity and reliability of the International Classification of Diseases, Tenth Revision (ICD-10) codes for external-cause injuries?

Rationale The International Classification of Diseases (ICD) codes are used worldwide in all areas of healthcare as a coding system to report diagnoses in hospital databases, including classifying diagnoses for various diseases, disorders, injuries, and other health conditions, symptoms, and procedures. In addition to being a coding diagnostic reporting system, they may be used for billing purposes, claims processing, medical care review, classifying data, and for healthcare statistics reporting [1]. The International Classification of Diseases is the most widely used classification system for hospital records, and approximately 70% of global health expenditure is distributed according to their data [2,3]. Therefore, accurate reporting of these codes is essential for maintaining high-quality healthcare data worldwide.

The 10th revision of ICD codes (called ICD-10) was developed by the World Health Organization (WHO) and are currently used worldwide [2,3]. These codes have been in effect since approximately year 2000, though this varies by country. Despite their wide use in healthcare, the overall validity and reliability of these codes for external-cause injuries has yet to be examined. Individual studies have reported their validity and reliability for different types of injuries, but an overall analysis of the ICD-10 codes' accuracy to diagnose/identify the correct conditions based on how they are coded has not been reported for these outcomes. This includes a gap in the literature describing an overall statistic of whether the ICD-10 codes for external cause injuries

recorded describe the condition accurately (i.e., validity), and whether they are coded consistently amongst healthcare workers (i.e., reliability).

Injuries are a prevalent issue worldwide, as worldwide deaths due to all injuries has increased from 4,260,493 (UI: 4,085,700 to 4,396,138) in 1990 to 4,484,722 (4,332,010 to 4,585,554) in 2017 [4]. Furthermore, all-injury incidence (i.e., new cases) increased from 354,064,302 (338,174,876 to 371,610,802) in 1990 to 520,710,288 (493,430,247 to 547,988,635) in 2017, which was found in the Global Burden of Disease Study [4]. Thus, accurate reporting of injuries is critical so healthcare providers, government officials, and policy makers can be informed about injury rates and which types are most prevalent, and for accurate claims reporting. This allows for an understanding of where public health actions or other healthcare actions may be beneficial to make decisions and take action to prevent injuries and treat them better. Furthermore, since ICD-10 codes are one of the primary sources of information for reporting diagnoses, the analysis of their accuracy is especially important.

Therefore, our study aims to investigate the validity and reliability of ICD-10 codes for external-cause injuries to report the overall accuracy of these codes in identifying the correct diagnoses (i.e., validity), and whether reporting is consistent amongst individuals coding them (i.e., reliability).

Condition being studied This review is examining external cause injuries. This includes resulting injury codes and external cause of the injury codes. External cause of injury codes are a subset of ICD-10 codes which classify injuries by the two main component mechanisms and injury intent.

They have two main components: 1) the vector that transfers energy to the body (e.g., burns, falls, motor vehicle traffic accident) and 2) the injury intent (whether the injury was purposefully inflicted and whether it was self-inflicted or inflicted by another). The categories for intent of injury include unintentional, homicide/assault, suicide/intentional self-harm, legal intervention or war operations, and undetermined intent [5].

METHODS

Search strategy Ovid MEDLINE:
1 Injur*.tw,kf. 1002545
2 Traumatic brain injur*.tw,kf. 47934
3 Transport incident*.tw,kf. 23
4 Crash*.tw,kf. 17122
5 Fall*.tw,kf. 247104
6 Drown*.tw,kf. 6167
7 Burn*.tw,kf. 122628
8 (Fire* adj3 injur*).tw,kf. 2608

9 Poisoning*.tw,kf. 80342
10 Violence.tw,kf. 63553
11 exp Accidents, Traffic/ or exp Accidents, Home/ or exp Accidents/ or exp Accidents, Occupational/ 208365
12 exp "Wounds and Injuries"/ 1002562
13 exp Accidental Falls/ 27923
14 exp Domestic Violence/ or exp Intimate Partner Violence/ 54597
15 exp Spouse Abuse/ or exp Physical Abuse/ or exp Child Abuse/ 41837
16 exp Fractures, Bone/ 206775
17 exp Hip Fractures/ 28497
18 exp Spinal Fractures/ 17487
19 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 2201294
20 Reliability.tw,kf. 208188
21 Validity.tw,kf. 212478
22 Validation.tw,kf. 296078
23 exp "Reproducibility of Results"/ 463148
24 exp "Sensitivity and Specificity"/ 645717
25 Sensitivity.tw,kf. 967906
26 Specificity.tw,kf. 550010
27 20 or 21 or 22 or 23 or 24 or 25 or 26 2325303
28 ICD 10*.tw,kf. 15328
29 ("International Classification of Diseases" and (tenth revision* or "10")).tw,kf. 6656
30 28 or 29 18903
31 19 and 27 and 30 313
Cochrane Library:
#1(Injur*):ti,ab,kw 74035
#2(Traumatic brain injur*):ti,ab,kw 4868
#3(Transport incident*):ti,ab,kw 66
#4(Crash*):ti,ab,kw 755
#5(Fall*):ti,ab,kw 27261
#6(Drown*):ti,ab,kw 144
#7(Burn*):ti,ab,kw 12640
#8(Fire* near/3 injur*):ti,ab,kw 79
#9(Poisoning*):ti,ab,kw 2382
#10(Violence):ti,ab,kw 3907
#11[mh "Accidents"] 21062
#12[mh "Accidents, Traffic"] 543
#13[mh "Accidents, Home"] 96
#14[mh "Accidents, Occupational"] 112
#15[mh "Wounds"] 34224
#16[mh "Injuries"] 34224
#17[mh "Accidental Falls"] 1921
#18[mh "Domestic Violence"] 1121
#19[mh "Intimate Partner Violence"] 553
#20[mh "Spouse Abuse"] 224
#21[mh "Physical Abuse"] 56
#22[mh "Child Abuse"] 705
#23[mh "Fractures, Bone"] 8166
#24[mh "Hip Fractures"] 2154
#25[mh "Spinal Fractures"] 973
#26{or #1-#25} 144626
#27(Reliability*):ti,ab,kw 13134

#28(Validity*):ti,ab,kw 13168
#29(Validation*):ti,ab,kw 16009
#30[mh "Reproducibility of Results"] 14526
#31[mh "Sensitivity and Specificity"] 19899
#32(Sensitivity):ti,ab,kw 67965
#33(Specificity):ti,ab,kw 23272
#34{or #27-#33} 114285
#35(ICD 10*):ti,ab,kw 3789
#36((International Classification of Diseases) and (tenth revision* or 10)):ti,ab,kw 1027
#37{or #35-#36} 4432
#38 #26 and #34 and #37 38
EMBASE:
1 Injur*.tw,kf. 1358915
2 Traumatic brain injur*.tw,kf. 71747
3 Transport incident*.tw,kf. 30
4 Crash*.tw,kf. 20062
5 Fall*.tw,kf. 360147
6 Drown*.tw,kf. 8148
7 Burn*.tw,kf. 170456
8 (Fire* adj3 injur*).tw,kf. 3448
9 Poisoning*.tw,kf. 102171
10 Violence.tw,kf. 76517
11 exp Accidents, Traffic/ or exp Accidents, Home/ or exp Accidents/ or exp Accidents, Occupational/ 253050
12 exp "Wounds and Injuries"/ 2882368
13 exp Accidental Falls/ 48996
14 exp Domestic Violence/ or exp Intimate Partner Violence/ 73728
15 exp Spouse Abuse/ or exp Physical Abuse/ or exp Child Abuse/ 64374
16 exp Fractures, Bone/ 391898
17 exp Hip Fractures/ 49561
18 exp Spinal Fractures/ 38043
19 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 4022237
20 Reliability.tw,kf. 262617
21 Validity.tw,kf. 267250
22 Validation.tw,kf. 432243
23 exp "Reproducibility of Results"/ 257268
24 exp "Sensitivity and Specificity"/ 479426
25 Sensitivity.tw,kf. 1319191
26 Specificity.tw,kf. 747488
27 20 or 21 or 22 or 23 or 24 or 25 or 26 2654161
28 ICD 10*.tw,kf. 33394
29 ("International Classification of Diseases" and (tenth revision* or "10")).tw,kf. 9731
30 28 or 29 38613
31 19 and 27 and 30 484
32 Injur*.tw,kf. 1358915
33 Traumatic brain injur*.tw,kf. 71747
34 Transport incident*.tw,kf. 30
35 Crash*.tw,kf. 20062
36 Fall*.tw,kf. 360147
37 Drown*.tw,kf. 8148
38 Burn*.tw,kf. 170456

39 (Fire* adj3 injur*).tw,kf. 3448
40 Poisoning*.tw,kf. 102171
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48 exp Hip Fractures/ 49561
49 exp Spinal Fractures/ 38043
50 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 4022237
51 Reliability.tw,kf. 262617
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56 Sensitivity.tw,kf. 1319191
57 Specificity.tw,kf. 747488
58 51 or 52 or 53 or 54 or 55 or 56 or 57 2654161
59 ICD 10*.tw,kf. 33394
60 ("International Classification of Diseases" and (tenth revision* or "10")).tw,kf. 9731
61 59 or 60 38613
62 50 and 58 and 61 484
Scopus:
(TITLE-ABS-KEY (injur* OR (traumatic AND brain AND injur*) OR (transport AND incident*) OR crash* OR fall* OR drown* OR burn* OR fire* OR poisoning* OR violence OR violent OR accident OR traffic OR wound* OR fracture*) AND TITLE-ABS-KEY (((reliability* OR validity* OR sensitivity OR specificity OR reliability* OR validation) OR (reproducibility AND of AND results))) AND TITLE (((icd AND 10*) OR (international AND classification AND of AND diseases AND tenth AND revision*) OR (international AND classification AND of AND diseases AND 10))) AND ABS (((icd AND 10*) OR (international AND classification AND of AND diseases AND tenth AND revision*) OR (international AND classification AND of AND diseases AND 10)))).

Participant or population The population includes patients that have experienced an external injury of all ages from any country. Only cases that examined and recorded these injuries with the specified ICD-10 injury codes are to be included in the analysis. The ICD-10 codes we selected for our analysis to categorize and present injury data were based on the reliable standards reported by the Association of Public Health Epidemiologists in

Ontario (APHEO), Parachute's 2022 guidelines for ICD-10 code classifications used to document injury causes, and the International Classification of Diseases and Health Related Problems, Tenth Revision, Canada (ICD-10-CA) [5-7]. The codes included are based on the ICD-10-CA codes, as these are the most commonly used ICD-10 injury codes that are applicable (i.e., overlap) to classify injuries in all countries. The ICD-10 codes used in the inclusion criteria to classify external injuries are: (1) Unintentional Injuries: V01-X59, Y85-Y86; W25-W29, W45, W46, X00-X19, X00-X09, X10-X19, W65-W74, V90, V92, W65, W66, W67, W68, W69, W70, V90, V92, W00-W19, X40-X49, W75-W84, X50, W42, W43, W53-W64, W92-W99, X20-X39, X51-X57, W20-W22, W50-W52, V02-V04, V09.0, V09.2, V12-V14, V19.0-19.2, V19.4-V19.6, V20-79, V80.3-80.5, V80.9, V81.0-81.1, V82.0-82.1, V82.8, V83-V86, V87 (.0-.8), V88 (.0-.8), V89.0, V89.2, V01-V09, V02-V04 (.1, .9), V09.2, V02-V04 (.0), V09 (.0), V01, V05, V06, V09 (.1, .3, .9), V10-V19, V12-V14 (.3-.9), V19 (.4-.6), V12-14 (.0-.2), V19 (.2), V10-11, V15-V18, V19 (.3, .8, .9), V05, V15, V25, V35, V45, V55, V65, V70-79, V81, V82, V70-79, V05, V15, V25, V35, V45, V55, V65, V75, V81, V82, V86, V86.00, V86.10, V86.30, V86.50, V86.51, V86.60, V86.61, V86.90, V86.91, V86.08, V86.18, V86.2, V86.38, V86.4, V86.58, V86.68, V86.7, V86.98; (2) Intentional Injuries: X60-Y09, Y87.0, Y87.1, X60-X84, Y87.0, X85-Y09, Y87.1; (3) Sports and Recreation: W22.05, W51.05, W21.00, W21.01, V10-V19, W02.02, W02.03, W02.08, W22.03, W51.03, W21.02, W21.03, W22.02, W51.02, W02.00, Prior to year 2009: the ICD10 code is W09 and from 2009 and onwards: subcategories were introduced and the ICD10 codes are now W09.00-W09.09, W16, W67-W74, W02.01, W02.04, W22.00, W51.00, W22.04, W51.04, W22.01, W51.01, V90-V94, only (0.2-0.8), V86, V86.08, V86.19, V86.2, V86.4, V86.5, V86.6, V86.7, V86.9, V86.38, V86.58, V86.68, V86.98, V86.00, V86.10, V86.30, V86.50, V86.51, V86.60, V86.90, V86.91, W02.08, W21.08, W21.09, W22.07, W51.07; (4) Injuries, poisoning and certain other consequences of external causes related to body regions: S00-S09, S10-S19, S20-S29, S30-S39, S40-S49, S50-S59, S60-S69, S70-S79, S80-S89, S90-S99, T00-T07, T08-T14, T15-T19, T20-T32, T36-T50, T51-T65, T66-T78, Z61.6, T90-T98, Y10-Y19, and Y20-Y34.

Intervention The intervention being evaluated in this review is the validity and/or reliability reported for the specified ICD-10 injury codes.

Comparator Studies will be included which compared the reported ICD-10 injury codes to chart review and/or physician diagnosis as the gold standard (for validity measures) and/or those that compared ICD-10 injury codes between coders or other healthcare workers (i.e., inter-rater reliability for reliability measures).

Study designs to be included Articles must be primary published studies, original, and peer reviewed. Any study design that meets this criterion examining the validity and/or reliability of ICD-10 codes for the external injuries specified for this study will be included. Articles must be published in English and have full-text available.

Eligibility criteria Inclusion criteria: Studies that examined validity and/or reliability for the specified ICD-10 injury codes are to be included in the analysis. Validity and reliability are defined by the outcome measures described in the 'Main Outcomes' section below. The specified ICD-10 injury codes being investigated in this review are listed in the 'Participants' section above. All studies included must be peer reviewed, primary articles, published in English, examining humans, and have full-text available. All ages and countries are included. In studies where only some of the codes examined were ICD-10 injury codes, the relevant results will be extracted if they are reported as separate outcome values in the paper. Exclusion criteria: Non-human studies, studies examining ICD codes other than ICD-10 codes only, studies that only examine ICD-10 codes for conditions other than external cause injuries, non-peer reviewed studies, non-English studies, and non-full-text studies.

Information sources The databases used for this systematic review include Ovid MEDLINE, EMBASE, COCHRANE, and SCOPUS, from all dates available (1966-2023, 1947-2023, 1996-2023, 1996-2023, respectively). The searches were conducted on the following dates, from database inception to current date: Ovid MEDLINE (April 16/2023), Cochrane Library (April 18/2023), EMBASE (April 18/2023), and Scopus (April 19/2023). Also, a supplementary search of the literature was conducted via the authors manually searching the publications in the reference lists of all relevant articles.

Main outcome(s) The outcome measures to be analyzed to assess the validity and reliability of external injury ICD-10 codes include: (1) sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for validity, and (2) inter-rater reliability, measured by Krippendorff's alpha, Cohen's Kappa, or Fleiss' kappa, for reliability.

Additional outcome(s) No additional outcomes are planned to be examined at this time. However, depending on the number of results from all studies and the complexity of the analysis we may split this review into two manuscripts for clarity.

Data management The data that will be collected for analysis includes the reported values for sensitivity, specificity, PPV, and NPV (i.e., validity measures), and inter-rater reliability, measured by Krippendorff's alpha, Cohen's Kappa, or Fleiss' kappa (i.e., reliability measures). Two reviewers independently screened the studies. Any disagreements were discussed with a third reviewer. Article screening and full-text review was completed using covidence software, and Zotero software was used for extracting articles. Rstudio and Excel will be used for data analysis and for figure generation. Data and manuscript work will be saved on the secure hospital network drive at our center.

Quality assessment / Risk of bias analysis All studies included in our analysis are assessed for risk of bias to investigate study quality using an adaption of the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) tool [8]. Factors such as the study design, patient population, and comparison to the chosen gold standard all may impact the results of the studies included in our paper. Thus, we are using the QUADAS protocol to analyze each study and report these findings to be considered when reviewing our results. The Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) system will also be applied to assess the quality of evidence as this is a transparent method to assess the quality of evidence of systematic reviews [9].

Strategy of data synthesis Quantitative data will be extracted from the articles for all outcomes of interest. Mean values will be calculated for all outcomes reported as overall values for sensitivity, specificity, PPV, NPV, and inter-rater reliability, measured by Krippendorff's alpha, Cohen's Kappa, or Fleiss' kappa. This will provide an overall value for each of these parameters to represent the accuracy of the ICD-10 injury codes.

Subgroup analysis Injury codes will be split into "injury types" categories to be presented in the results section. This will be done in addition to individually reporting all outcomes for all codes included.

Sensitivity analysis Sensitivity analysis is not planned at this time due to the nature of the data.

Language restriction Only peer-reviewed studies published in English are considered for inclusion.

Country(ies) involved Canada.

Keywords International Classification of Diseases Codes, Tenth Revision; Validity; Reliability; Diagnostic accuracy; Injury outcomes; External cause injuries.

Dissemination plans The results of this systematic review will be published in a peer-reviewed journal.

Contributions of each author
Author 1 - Sarah Paleczny - Contributions: All parts of the review, including developing and designing the review; writing the protocol; developing the search strategy; running the search strategy and uploading articles; article screening and full-text review; risk of bias assessment; data collection; data analysis; data interpretation; figure and table generation; manuscript writing; manuscript submission.
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Author 2 - Nosakhare Osagie - Contributions: Article screening and full-text review; risk of bias assessment; protocol writing; data collection; data interpretation; figure and table generation; manuscript writing.
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Author 3 - Jai Sethi - Contributions: Data analysis; figure and table generation.
Email: jai.sethi@unityhealth.to
Author 4 - Michael Cusimano - Contributions: All parts of the review, including developing and designing the review; actively advising for all sections at all stages of the review; manuscript writing.
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