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Classifying External Causes of Injury: History, Current Approaches, and Future Directions

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The *International Classification of Diseases* (ICD) is used to categorize diseases, injuries, and external causes of injury, and it is a key epidemiologic tool enabling storage and retrieval of data from health and vital records to produce core international mortality and morbidity statistics. The ICD is updated periodically to ensure the classification system remains current, and work is now under way to develop the next revision, ICD-11. It has been almost 20 years since the last ICD edition was published and over 60 years since the last substantial structural revision of the external causes chapter. Revision of such a critical tool requires transparency and documentation to ensure that changes made to the classification system are recorded comprehensively for future reference. In this paper, the authors provide a history of the development of external causes classification and outline the external cause structure. They discuss approaches to manage ICD-10 deficiencies and outline the ICD-11 revision approach regarding the development of, rationale for, and implications of proposed changes to the chapter. Through improved capture of external cause concepts in ICD-11, a stronger evidence base will be available to inform injury prevention, treatment, rehabilitation, and policy initiatives to ultimately contribute to a reduction in injury morbidity and mortality.

accidents; classification; public health, wounds and injuries

Abbreviations: ICD, *International Classification of Diseases*; ICECI, International Classification of External Causes of Injury; WHO, World Health Organization.

INTRODUCTION

The *International Classification of Diseases* (ICD) is the system used to categorize diseases, injuries, and external causes of injuries for compilation and comparison of morbidity and mortality data internationally (1). The ICD is a key epidemiologic tool enabling storage and retrieval of data from health and vital records over time and place to produce core national and international statistics. The World Health Organization (WHO) estimates that approximately 70% of global health expenditure is distributed according to ICD-coded data, 110 countries use the latest version of the ICD for mortality coding, and ICD has been cited in over 20,000 scientific articles (2).

Since the beginning of the 20th century, the ICD has been revised about once every 10 years, except for the nearly 20-year interval between the last 2 revisions, the *International Classification of Diseases*, Ninth Revision (ICD-9) and the *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision (ICD-10) (3). Work is under way to develop the next revision, *International Statistical Classification of Diseases and Related Health Problems*, Eleventh Revision (ICD-11). The ICD is updated periodically to ensure that the classification remains current and capable of capturing emerging diseases, advances in science and technology, and changing needs of users.

The ICD revision process needs to ensure that ICD-11 remains consistent with ICD-10 to enable comparability over time, while still addressing known concerns and enhancing the classification's clinical and public health utility (2). The revised classification also needs to be interoperable within both electronic and paper-based health information environments and be able to accommodate clinical and technological advances across the health care continuum over time. It

has been more than 60 years since the last substantial structural revision of the external causes chapter. Over this time, there have been significant advances in computing technology and information management capacity; hence, now is the time, as described by the developers of the *International Classification of Diseases*, Sixth Revision (ICD-6) external causes chapter, for another ''bold attack'' on the known deficits of the ICD for external causes (4). In 1982, before ICD-10 was introduced, Susan Baker stated the following:

> The time has come for a fresh look at the ICD injury codes. If the result is sufficiently logical, simple and relevant, the payoff should be wider use of the ICD and, ultimately, more effective control of injuries (5, p. 201).

This statement is still just as relevant and timely for the development of ICD-11.

In this paper, we provide a history of the development of external causes of injury classification and summarize changes between ICD-9 and ICD-10. We illustrate how the ICD-10 external causes codes structurally represent causal elements and outline criticisms of this approach. We summarize approaches to manage ICD-10 deficiencies, including statistical techniques, clinical modifications, and development of alternative classification systems. The ICD-11 revision processes are broadly outlined, and, while the revision process is ongoing as this is being written, our current approach regarding the development of, rationale for, and implications of proposed changes to the external causes chapter are discussed.

HISTORY AND CRITIQUE OF CLASSIFICATION OF EXTERNAL CAUSES IN ICD

External causes of injury are critical for understanding an injury event and identifying intervention opportunities (6). Even very early in ICD history, an injury's external cause was seen as crucial for injury prevention purposes (7). Harrison (7) described the evolution of ICD external causes classification, and the core points are summarized below.

- In the mid-19th century, William Farr developed the classification of causes of death used for the first-ever national death register, in England and Wales. Farr advocated international standardization of classification, and his approach to conceptualizing and coding external causes is still recognizable in the ICD. He established the importance of physical and chemical forces resulting in ''violent deaths or diseases'' by considering these as 1 of the 5 major disease categories. Three causal factors important for injury prevention were captured under the Farr system: ''human agency,'' ''mode in which death is produced,'' and ''circumstances in which fatal accidents occur.''
- The International List of Causes of Death, based on work by Jacques Bertillon and adopted in 1893, is the direct ancestor of the ICD (3). The list was first revised in 1900 and then about once per decade. Although not termed ICD until later, this list was the basis for numbering revisions of the ICD.
- The sixth revision of the ICD (adopted in 1948; the first published under the auspices of WHO) included the most substantial changes to the classification of injuries and external causes. For the first time in the history of the classification, the nature of the injury and details as to how it occurred (external causes) were divided into distinct sections. This distinction has persisted (7).
- Changes since the sixth revision consist largely of adding specificity and detail to code blocks within the external causes chapter, with limited structural changes being made in the last 60 years (7). A section was added to the eighth revision for ''Injury undetermined whether accidentally or purposely inflicted.''
- In ICD-6 through ICD-8 (*International Classification of Diseases*, Eighth Revision), the classifications of injury and of external causes were described as alternative classifications, either or both of which could be used. In ICD-9, the injury chapter was included in the main sequence of disease chapters, and the external causes chapter was described as ''supplementary,'' a designation that was removed in ICD-10.

The ICD was developed with coding of causes of death as its main purpose. While sometimes also used to code hospital cases, the requirements of that ''use case'' are sufficiently different to have prompted the development of ''clinical modifications'' of ICD-9 and ICD-10 (3). Most of the modifications are subdivisions of categories to allow more specific coding of diagnoses. However, the external causes classification has also been altered in some clinical modifications, which is discussed in more detail in latter sections of this paper.

External causes coding of mortality and morbidity

Despite wording changes in the ICD, use of the external causes chapter for coding the underlying causes of deaths recorded in vital registers has remained more or less unchanged for many decades. Several dimensions are required for complete capture of an external cause. The ICD-10 core code at the 3-character level provides detail about the intent behind the incident, the mechanism causing the injury, and, for some mechanisms, the object/substance that was involved. For certain code ranges, an additional character is added to the 3-character code following a point separator to provide information about place of occurrence—where the incident took place.

A further element that may be coded relates to the activity of the injured person at the time of the incident. This is a new dimension introduced in ICD-10 but is currently an optional code element that may be added to the end of the core code or stored as a separate data item. Thus, a complete external causes code contains a number of different elements within the one code structure. This is known as precoordination. The rules and guidelines for selecting the underlying cause are found in the second of the 3 ICD-10 volumes (8). The other 2 volumes, known as the Alphabetic Index and the Tabular List, are used together to locate the correct code for the selected cause.

Underlying cause of death coding for injury-related fatalities has always been limited to the coding of a single external cause code. The practice for injury and external causes can

be summarized as follows: if an injury is found to be the underlying cause of death, then code the external cause of that injury rather than the type of injury as the underlying cause (1).

The practice of coding episodes in hospitals differs and has been more variable. Distinct from deaths coding, the first priority is typically coding of the diagnosis (disease or injury) that best accounts for the hospital stay. Usually, additional diagnoses are also coded. As opposed to death coding, external causes may not be coded at all. When external causes are coded for morbidity episodes, then the process can be summarized as follows: if an injury has been coded as a diagnosis, then code also the external cause of that injury. Most ICD-10 clinical modifications elaborate this coding guidance to the following: if an external cause of injury has been coded, then code also the place of occurrence and the activity at the time of injury.

It is important to understand the broad changes between ICD-9 and ICD-10, because they can inform revisions to ICD-11. ICD-10 changed to an alphanumeric system from the primarily numeric system of ICD-9. This change enabled a large expansion in the number of codes, allowing for increased definitional precision of most external causes of injury and diseases (although this precision was not utilized for poisoning or firearm codes with a loss of precision between ICD-9 and ICD-10 for these mechanisms).

The external causes chapter was grouped into blocks of related conditions, at the highest level according to the intent behind the incident (e.g., accidental, intentional self-harm, assault). Place of occurrence codes were expanded and applied to a wider range of external causes codes. Activity codes were introduced, as discussed above. Transport accidents in ICD-10 were grouped into smaller blocks according to the characteristics of the injured person (pedestrian, motorcycle rider, etc.), whereas, in ICD-9, transport accidents were grouped by vehicle type. Coding rules for the selection of underlying causes of death were modified, potentially affecting assignment of external causes codes. Codes for complications of medical and surgical care were removed from unintentional or accidental injuries and included as a separate block. Table 1 summarizes the changes between ICD-9 and ICD-10.

Current approaches to external causes classification in ICD-10

Broad structure of ICD-10 external causes classification. ICD was initially designed for the mortality use case, which has, as underlying principles, the need to provide a *single* code for an underlying cause of death and to maintain comparability of categories over time. Because of the requirement for one underlying cause of death, the codes in the external causes chapter in ICD-10 are precoordinated as a way of embedding the required core external causes dimensions in single codes. However, to ensure usability of the classification internationally and that codes do not become unwieldy for use in lower resourced settings, the number and format of characters allowable in the code string have traditionally been limited. This limits the amount of information by enforcing a cap on the number of concepts that can be captured in the code, which can affect the quality of the external causes classification.

Table 2 summarizes the structure and content of ICD-10 for the core external causes dimensions for each intent block. Place and activity dimensions are not included in the table, although place does form part of the complete ICD-10 external causes code and activity is an optional dimension. The same 10 options for place codes (0–9) are used as fourth-character subdivisions for all intent blocks and mechanisms (except for V00–V99 Transport accidents and Y06–Y07 Neglect and maltreatment). As noted above, activity codes are provided for optional use with most intents and mechanisms, and the same activity values (0–9) are used for all such codes.

Objects and substances involved in the cause of an injury or poisoning are embedded in the external causes codes as part of the mechanism, for example, W05 Fall (i.e., the mechanism) involving wheelchair (i.e., the object). Mechanism and object are somewhat fluid concepts in the ICD. Some categories refer specifically to that aspect which directly produced injury (e.g., Striking against or struck by sports equipment, or Contact with hot tap-water) or that describe the initiation of an injurious event (e.g., Fall on same level from slipping, tripping and stumbling) or describe aspects of a complex event without detailing the injurious mechanism and/or object(s) (e.g., Car occupant injured in non-collision accident, or Orthopedic devices associated with adverse incidents).

Intent blocks in ICD-10 are identified by groups of consecutive alphanumeric codes. Within each intent block, subblocks of mechanisms are likewise identified by consecutive codes. Mechanism blocks are more numerous and detailed within the Accidents block compared with Intentional self-harm, Assault, or Events of undetermined intent blocks. However, mechanisms similar to those that appear in the Accidents block can still be identified in other intent blocks through code descriptions. In Table 2, these mechanism blocks are signified by italicized font against the code ranges to which they could be applied. However, in ICD-10 it is difficult to select all codes referring to the same mechanism (e.g., falling or drowning) across all intent blocks. Some mechanism blocks are fairly specific, and their titles provide a good indication of their contents (e.g., Accidental drowning and submersion), while others are more abstract or opaque (e.g., Exposure to inanimate mechanical forces). Objects/substances are contained within individual code descriptions, and only a limited number of objects (firearm type, poisoning substance, and motor vehicle) are present across all intent blocks. Intent blocks other than Accidents typically have only a small number of objects/substances included.

Problems with the ICD-10 approach to classifying external causes. With the need to capture multiple external cause dimensions in a single code, as well as restrictions on the number and format of allowable characters in the code and the emphasis on ensuring backward compatibility with each ICD revision, the external causes chapter significantly simplifies injury dimensions to core phenomena deemed important by classification developers. A central purpose of the external causes of injury chapter is to capture information to inform injury prevention initiatives (9).

Table 1. Changes to the External Causes of Injury Chapter from ICD-9 to ICD-10

Level of Change	Details
Terminology changes	
Chapter name	Changed from "Supplementary classification of external causes of injury and poisoning" to "External causes of morbidity and mortality."
Category names	Within the external causes chapter, "Suicide" changed to "Intentional Self Harm" and "Homicide" to "Assault."
Structural changes	
Coding system	A primarily numeric system changed to alphanumeric. External causes chapter changed from the E800 to E999 code range to codes prefixed with a V, W, X, or Y.
Number of codes	A large expansion in the number of codes, allowing for increased definitional precision of external causes of injury and diseases.
Broad code block changes	
Place of occurrence	Revised place of occurrence codes and wider range of external causes codes to which they can be applied.
Activity at time of injury	Introduction of an Activity code to capture the activity the person was doing at the time of injury.
Transport accidents	Transport accidents in ICD-10 were grouped by the characteristics of the injured person (pedestrian, motorcycle rider, etc.); in ICD-9, transport accidents were grouped by vehicle type.
Specific code changes	
Motor vehicle accidents	ICD-9 allowed cases to be assigned as motor vehicle related if they occurred on a highway/road without specification of vehicle type. ICD-10 requires explicit statement that the vehicle is a motor vehicle (as distinct from animal-drawn transport, etc.); otherwise, the case is coded as an unspecified vehicle in "other land transport accidents."
Falls	ICD-9 classified cases where a fracture had occurred but no cause was documented as "E887 Fracture, cause unspecified," which is grouped within the E880-E888 Accidental Falls group. ICD-10 assigns these cases to "X59 Exposure to Unspecified Factor," which is not grouped with the Accidental Falls category.
Hanging, suffocation, strangulation	Codes are less specific in ICD-10 than in ICD-9.
Firearms	Codes are less specific in ICD-10 than in ICD-9.
Poisonings	Some changes in the classification of deaths due to accidental poisoning under ICD-9 to mental and behavioral disorders due to substance abuse in ICD-10.
	Less detail in the codes for external causes of poisoning in ICD-10 compared with ICD-9, with more detail in ICD-10 for the substance-specific codes found in the Injury chapter.
Rules/guideline changes	
Coding rules	Changes and clarification to coding rules relating to the selection of underlying causes of death, affecting external causes code assignment.
Rankable causes of death	Complications of medical and surgical care codes were removed from unintentional or accidental injuries and included as a separate 'block' similar to "Accidents" and "Intentional self-harm."

Abbreviations: ICD-9, *International Classification of Diseases*, Ninth Revision; ICD-10, *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision.

Critique of the external causes of injury chapter must consider this need. Detailed information regarding the causal elements of an injury is required for injury prevention research. This includes, but is not limited to, causal mechanism, objects involved, intent of the injured person or perpetrator (for assault/homicide), place or setting of the incident, and the activity of the injured person at the time of the injury (e.g., work related, during sporting activity). The system should also allow for aggregation of these elements for comparative purposes over time, place, and population subgroups. If the ICD does not satisfy these injury prevention requirements, there is a considerable risk that alternative classification systems may proliferate, significantly limiting comparability of systems and utility of data (10).

Limitations to the ICD-10 external causes chapter have been identified by stakeholders including, among others, ministries of health, statistical agencies, researchers, and injury control agencies. To identify the chief concerns with ICD-10, we conducted a review of recent published literature. This review also included documents from the WHO Morbidity and Mortality Reference Groups. These are the groups responsible for monitoring the ICD classification and identifying concerns from mortality (death) and morbidity (hospital episodes) perspectives. Comments from the group responsible for updating ICD to the 11th revision were also compiled.

Concerns raised in the various sources are summarized in Table 3. Some concerns identified were not new, reflecting issues raised as early as 1982 in the transition from ICD-9 to ICD-10 (5, 10, 11). Furthermore, it must be clearly recognized that ICD codes will ever be only as accurate and useful as the documentation in the source records, and some of the critique of ICD-coded data is as much a reflection of poor documentation practices as it is of limitations of the ICD system.

Table 2. ICD-10 Structure and Content of Core Dimensions for Main Intent Blocks[a]

Intent	Mechanism	Object/Substance
V00–X59 Accidents	V00–V99 Transport	Injured person/counterpart mode of transport, traffic/nontraffic, injured person role
	W00–W19 Falls	Snow/ice, conveyances, furniture, structures
	W20–W49 Exposure to inanimate mechanical forces	Sport equip, sharp object, machinery, firearm, pressurized object
	W50–W64 Exposure to animate mechanical forces	People, animals, plants
	W65–W74 Accidental drowning and submersion	Water "container"
	W75–W84 Other accidental threats to breathing	Bed, earth substance, food
	W85–W99 Exposure to electric current, radiation, ambient air temp and pressure	Transmission lines
	X00–X09 Exposure to smoke, fire and flames	Building, flammable material, nightwear, clothing, apparel
	X10–X19 Contact with heat and hot substances	Liquids, solids, gas, appliances, metals, machinery
	X20–X29 Contact with venomous animals and plants	Insects, animals, plants
	X30–X39 Exposure to forces of nature	Heat, cold, storms, earth movements, floods
	X40–X49 Poisoning by/exposure to noxious substances	Class of substance (drugs and medications; other types of substances)
	X50–X57 Overexertion, travel and privation	Food, water
	X58–X59 Exposure to other and unspecified factors	Nil
X60–X84 Intentional self-harm	X60–X69 *Poisoning by/exposure to noxious substances*	Class of substance
	X70 *Threats to breathing*	Nil
	X71 *Drowning and submersion*	Nil
	X72–X75, X78–X79 *Exposure to inanimate mechanical forces*	Firearm, sharp object, blunt object
	X76–X77 *Exposure to smoke, fire and flames*	Nil
	X80 *Falls*	Nil
	X81–X82 *Transport*	Motor vehicle
	X83–X84 *Other and unspecified means*	Nil

Table continues

Approaches to dealing with ICD-10 external causes deficiencies

In response to identified deficiencies, data collectors and users have used a number of approaches to make allowances for and/or supplement poor external causes data. Reviewing these approaches provides additional evidence for the restructuring process for ICD-11. The main approaches include statistical methods to manage the external causes structure, development of clinical modifications, and development of alternative classification systems.

Statistical methods to manage external causes structure. ICD-10 external causes codes incorporate the intent, mechanism, and object dimensions within a single code. Because external causes codes are grouped by intent, code grouping algorithms are required to explore injury trends by mechanism.

The external causes of injury mortality matrix is the recommended international framework for aggregating and presenting ICD-coded external causes of injury data, developed specifically to facilitate comparability in the presentation of injury statistics. The matrix is a 2-dimensional array designed to present and easily extract both the mechanism and intent in meaningful categories and was devised to facilitate national and international comparability in the presentation of injury statistics (11). Matrices were developed for both ICD-9 and ICD-10, and they were jointly developed by the Injury Control and Emergency Health Services section of the US American Public Health Association, the International Collaborative Effort on Injury Statistics (12), and the US National Center for Health Statistics. The ICD-10 matrix was designed to be as consistent as possible with the ICD-9 matrix (13). Detailed information about the external causes matrix is available on the National Center for Health Statistics Web site (12, 14).

Clinical modifications of ICD-10. Some countries have expanded on the base ICD system to provide more comprehensive morbidity coding. These expansions are termed

Table 2. Continued

Intent	Mechanism	Object/Substance
X85–Y09 Assault	X85X90 *Poisoning by/exposure to noxious substances*	Class of substance
	X91 *Threats to breathing*	Nil
	X92 *Drowning and submersion*	Nil
	X93–X96, X99–Y00 *Exposure to inanimate mechanical forces*	Firearm, sharp object, blunt object
	X97–X98 *Exposure to smoke, fire and flames*	Nil
	Y01 *Falls*	Nil
	Y02-Y03 *Transport*	Motor vehicle
	Y04–Y05, Y07 *Exposure to animate mechanical forces*	Person
	Y06 *Privation*	Nil
	Y08–Y09 *Other and unspecified means*	Nil
Y10–Y34 Event of undetermined intent	Y10–Y19 *Poisoning by/exposure to noxious substances*	Class of substance
	Y20 *Threats to breathing*	Nil
	Y21 *Drowning and submersion*	Nil
	Y22–Y25, Y28–Y29 *Exposure to inanimate mechanical forces*	Firearm, sharp object, blunt object
	Y26–Y27 *Exposure to smoke, fire and flames*	Nil
	Y30 *Falls*	Nil
	Y31–Y32 *Transport*	Motor vehicle
	Y33–Y34 *Other and unspecified means*	Nil
Y35–Y36 Legal interventions and operations of war	Y35.0–Y35.4, Y36.0–Y36.5 *Exposure to inanimate mechanical forces*	Firearm, explosives, sharp object, blunt object, gas, weapons
	Y35.2, Y36.6 *Poisoning by/exposure to noxious substances*	Gas, biological weapons
	Y35.0–Y35.1, Y35.3–Y35.4, Y36.7–Y36.9 *Other and unspecified means*	Nil
Y40–Y84 Complications of medical and surgical care	Y40–Y59 *Poisoning by/exposure to noxious substances*	Class of substance
	Y60–Y61 *Exposure to inanimate mechanical forces*	Nil (type of procedure being performed)
	Y62–Y64, Y66 Failure sterile precautions, dosage, contaminated med/biol substance	Blood, fluid, radiation (+ type of procedure performed)
	Y70–Y84 Medical devices/surgical procedures associated with adverse effects	Medical specialty class of device/type of procedure
	Y65–Y69 *Other and unspecified means*	Nil

Abbreviation: ICD-10, *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision.
[a] Mechanism blocks are signified by italics against the code ranges to which they could be applied.

clinical modifications and aim to enhance country-specific public health surveillance and hospital utilization data. In addition, the Australian clinical modification of the *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision (ICD-10-AM) has been used for special mortality collections (e.g., Australian state/territory child death review teams) to allow for increased specificity as well as for mortality coding in New Zealand (15). Jetté et al. (3) describe available clinical modifications. Regarding external causes, the main clinical modifications, where changes have been made to the external causes of injury chapter of ICD-10, are the clinical modification of the *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision (ICD-10-CM) (developed in the United States), the clinical modification of the *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision (ICD-10-CA) (developed in Canada), and the ICD-10-AM.

Harrison (16) describes in detail the main ICD-10-AM expansions. There have been only limited changes to the external causes chapter of the ICD-10-AM since the edition we describe in this review. Changes to the ICD-10 external causes chapter for ICD-10-CA were described in an online report, with most relating to expansions of mechanisms of interest (17).

The clinical modification of the *International Classification of Diseases*, Ninth Revision (ICD-9-CM) is still used in

Table 3. Summary of Main Issues and Limitations of ICD-10 External Causes of Injury Chapter

Limitation	Description
Terminology/definitional issues	
Terminology	The term "Accidental" has been criticized, with "Unintentional" typically used in the injury research community (10).
Definitions	Lack of definitions of external causes terms and selection criteria (barring transport codes).
Structural issues	
Precedence of coding of intent, and precoordination of intent/mechanism/object	Intent coding takes precedence over mechanism, masking the impact of some mechanisms spread across differing intents and reducing the specificity of some mechanisms (10, 35). The chapter is essentially divided into 6 main intent blocks (accidental, intentional self-harm, assault, undetermined intent, complications, legal/war operations). Consequently, mechanism and object information must be duplicated in each intent. The "accidental" intent block has the most mechanism/object categories, with other intents having a smaller number of available codes. Hence, aggregation of injurious mechanism or object codes across intent blocks is not always possible.
Out of chapter codes	Most, but not all, of the categories and meta-information relevant to external causes are in Chapter 20. Some external cause elements are also found in
	Chapter 5, Mental and Behavioural Disorder: "F10–F19 disorders due to psychoactive substance use"
	Chapter 18, Symptoms and Signs codes: where limited information exists on death certificates and "R99 Other ill-defined and unspecified causes of mortality" are assigned
	Chapter 19, Injury, Poisoning and Certain Other Consequences of External Causes: objects/substances involved in poisonings/toxic effects, complications of medical/surgical care, maltreatment, and foreign bodies
	Chapter 21, Factors affecting health status codes: some codes within sections "Z04 Examination for other reasons" and "Z55–Z65 Persons with potential health hazards related to socioeconomic and psychosocial circumstances"
Noninjury diagnoses requiring external causes	Noninjury diagnoses may require an external cause code, for example, some diseases of the blood, endocrine/nutritional/metabolic disorders, nervous system disorders, eye and ear disorders, circulatory diseases, respiratory diseases, digestive disorders, and disorders of the skin. Hence, selection of cases based on external causes codes may also include noninjury cases and the diagnoses codes are required to ensure accurate case selection (36).

Table continues

US hospitals, and changes to the external causes chapter are made annually via the Coordination and Maintenance committee (18). ICD-10-CM has been developed and will be used for morbidity coding in the United States beginning in 2013. Many ICD-10-CM modifications reflect those made to ICD-9-CM and seek to maintain code specificity. ICD-10-CM is also available on the National Center for Health Statistics Web site (19).

Alternative classification systems. International Classification of External Causes of Injury (ICECI). Clinical modifications incorporate additional elements into the base ICD-10. However, alternative classification systems with broad structural changes have also been developed to address perceived ICD-10 external causes deficits.

ICECI provides a multidimensional approach to external causes data and was developed to improve specificity in a manner reflective of contemporary injury prevention theory and practice (20). In ICECI, multidimensional refers to the classification having separate codes to reflect each dimension of interest rather than a precoordinated code structure as in ICD-10. ICECI is a Related Classification in the WHO's Family of International Classifications (21) and helps define the domain of injuries being assessed; detail the circumstances of the injuries; and provide more detail about specific accident categories, such as home and leisure or traffic accidents. ICECI can be used at either a basic or expanded level of detail and has an extensive series of hierarchical code sets addressing intent, mechanism, object/substance, place of occurrence, activity when injured, alcohol use, and psychoactive drug or substance use. Supplementary modules can capture additional detail relating to transport, violence, place of occurrence, sports/recreation, and occupational injuries.

ICECI is considered a complement to ICD-10 external causes data. The ICD-10 external causes of injury mortality matrix was adopted as a bridge between ICECI and ICD-10, allowing for comparisons between aggregated injury data classified by either system (21). The ICECI was designed to be used in many settings, such as emergency departments, clinics, and inpatient hospital settings; for ad hoc studies/surveys; and in specialized mortality registration systems. The main identified uses are the US National Electronic Injury Surveillance System–All Injury Program; US National Health Interview Survey (response lists for place and activity questions); and in several research studies conducted in Korea, Jamaica, Palestine, Australia, Singapore, and the United States (9, 22–29).

Table 3. Continued

Limitation	Description
Broad code block issues	
Lack of code specificity for place and activity	Lack of specificity in relation to place of occurrence and activity at time of injury (including identification of the type of sport and occupational injuries) (9, 24, 28, 37–43).
Specific code issues	
Loss of specificity from earlier versions	Certain codes had decreased specificity in the transition from ICD-9 to ICD-10, such as firearms, hangings, and poisonings, as reported in Table 1 (10, 35, 44, 45).
Rules/guidelines affecting external causes	
Rules for assigning intent	Intent is difficult to determine from medical record documentation and death certificates. An inability to determine intent requires the coder to utilize default categories, typically "accidental." Intentional self-harm deaths and, to a lesser extent, assault may be inflated. Injuries due to unintentional causes are also artificially inflated (46, 47).
Restrictive inclusion/exclusion terms	In the absence of specific/explicit terms in source documents, ICD requires the use of default codes. Source documentation is notoriously scant, so these requirements for explicit content may be overly restrictive, for example, the requirement for "motor vehicle" to default to an unspecified code (described in Table 1) (48).
Lack of mutual exclusivity	Determination of which mechanism to code to may be complicated. For example, falls from or onto/into various objects require these injurious events to be coded to a nonfall mechanism (8). This problem arises from a lack of mutual exclusivity.
Recommended death certificate in ICD-10	The recommended death certificate does not prompt certifiers to indicate the causal elements involved in injury events. Poor documentation of external causes then adversely impacts coding quality and resultant mortality data (49–51).
Quality of external causes coding	
Quality issues in ICD-10	Studies examining external causes data quality for morbidity (9, 10, 24, 28, 37–43, 52–65) and mortality (41, 42, 47, 49, 50, 66–72) highlight reliability/accuracy problems: the use of residual codes ("other specified" or "unspecified") instead of more specific codes, lack of detail in death certificates impacting on the depth of coded mortality data, and a lack of available codes for injury areas of concern.

Abbreviations: ICD-9, *International Classification of Diseases,* Ninth Revision; ICD-10, *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision.

NOMESCO Classification of External Causes of Injury. In 1984, the Nordic countries, through the Nordic Medico-Statistical Committee (NOMESCO), developed the first multidimensional classification, known as the NOMESCO Classification of External Causes of Injury (30), to monitor emergency room patients. It is now in its fourth revision. The NOMESCO Classification of External Causes of Injury is not a WHO–Family of International Classifications–related classification, and maps between it and ICD-10 are not possible. Considerable differences in hierarchy and code structures and code values limit comparability of the NOMESCO Classification of External Causes of Injury with the ICD.

REVISING THE EXTERNAL CAUSES CLASSIFICATION FOR ICD-11

Broad ICD-11 revision process

As stated previously, the goals for the ICD-11 revision process are a user-friendly and scientifically credible classification to be used internationally (facilitating comparability), dynamic and responsive to clinical and scientific knowledge developments, underpinned by clinical terminologies and core taxonomic principles, and backward compatible and able to function in an electronic health environment (2). Descriptions of timelines and deliverables for the revision are available on the WHO Web site (2).

A Revision Steering Group oversees the process, with Topic Advisory Groups responsible for addressing content-specific domains (e.g., internal medicine, dermatology, mental health, injuries, and external causes). Content-specific Topic Advisory Groups are responsible for reviewing the ICD-10, identifying deficits, and documenting suggested changes in an online collaborative authoring platform (described in detail in a recent paper by its Stanford University (California) developers (31)). Several cross-sectional Topic Advisory Groups will review suggested changes and provide expertise in areas of mortality/morbidity classification, functioning and disability, and informatics.

Use cases for ICD-11

The needs of the traditional mortality and morbidity users are critical in the ICD revision, and their respective use cases are guiding the development. However, our group also recognizes the need for a research version of ICD-11 external

causes and a version for use in lower resourced settings. Hence, our proposals address the purposes and constraints of all use cases, as summarized below.

ICD-11 needs to facilitate the unique identification and coding of underlying causes of death but also needs to assist those countries that code so-called multiple causes of death. This refers to coding all causes reported on a death certificate, not just the underlying cause, providing a far richer set of data for analytical purposes. Even as multiple cause coding becomes more common because of the use of automated coding systems, as in previous ICD revisions, any mortality version of the classification needs to enable a single underlying cause of death code to be selected and assigned. This is important for ensuring comparability of trend data over time and place for significant categories and population subgroups. Sufficient documentation is also needed to describe the correspondence or mapping between ICD-10 and ICD-11. The mapping process provides a linkage or crosswalk between codes from one revision to the next, to facilitate trend analyses.

ICD-11 codes are also required for morbidity purposes: to enable capture of data regarding injuries requiring treatment in hospitals, ambulatory, and other health care settings; collection and dissemination of injury morbidity data for national and subnational priority setting; patient safety/quality of care indicators and identification of iatrogenic injury causes; and comparison of international injury morbidity trends. The morbidity use case is less constrained by the need for a single external cause code because many hospital information systems are designed to capture multiple codes describing diagnoses, comorbid conditions, procedures, and external causes. If systems already have multiple fields for each patient, introduction of a more multidimensional external causes structure can be accommodated.

By providing a clearer structure, the ICD-11 development can facilitate simpler extraction of relevant information for research purposes. Improving the coding of research data with ICD-11 may also help to standardize data collections internationally and improve comparability of research data with national morbidity and mortality data. The ICECI is being considered as a framework for the research version.

A simpler version of ICD-11 will facilitate data capture in lower resourced settings, for example, those with limited data collection resources (poorer countries) or those typically not resourced for external causes coding (hospital emergency departments). A lower resource setting use case requires clearly defined broad categories capturing each of the core dimensions, needs to be capable of being coded/compiled by individuals with limited or no coding experience, and must ensure meaningful comparisons with other ICD-11 data sets. This short form would include categories reflected in the broader hierarchical code structure and may be capable of completion in a paper-based format.

Summary of approach to revision of external causes in ICD-11

In summary, our Topic Advisory Group has focused on 4 main use cases: mortality, morbidity, research, and use in lower resourced settings. We are attempting to balance the need for comparability of important categories for long-term trend analyses and the intended purposes of the core use cases with the benefits of developing a more multidimensional approach. The injury policy and prevention communities require more uniform and complete capture of external causes information, and we aim to balance such needs for innovation and expansion with the equally important need for continuity (6).

As with previous revisions of the ICD, pragmatic constraints still prevail in the ICD-11 development process, with restrictions on code length, requirements for precoordinated codes for single-cause coding, and the need to retain backward compatibility and identifiability of concepts deemed to be of significant public health concern. Hence, this proposal aims to bring together the innovations developed in the ICECI model to fit the tight constraints of the ICD model. The current restructuring proposal combines a multidimensional foundation layer (based on the ICECI model (20)) with a mixture of multidimensional external causes components and a precoordinated external causes code list (capturing several external cause dimensions in the one code, using a standardized uniform code structure).

As this paper is being published, the revision process is still under way, and not all recommended changes may be implemented. We considered it important to record the decision processes to date to ensure transparency and inform future critiques of ICD-11. A series of unpublished discussion papers were distributed for comment in mid-2010 to experts internationally (32, 33) and were followed by a series of consultations with expert groups. The points outlined below represent a consolidated set of recommendations from this consultation process (34).

Recommended changes for ICD-11 external causes classification

Develop a uniform code structure. The most critical recommendation is for a more uniform, regularized code structure for external causes codes. This change should allow ICD-11 external causes to function in both a precoordinated (i.e., for underlying cause of death coding) and multidimensional modular (i.e., for morbidity, research, and lower resourced setting uses) fashion. Each core dimension (intent, mechanism, and object) should be represented in defined positions within the code string, thus allowing easy extraction from the code for analysis.

More specifically, within the code string, 1 character identifies intent, 2 characters identify mechanism (the first character identifying broad mechanisms and the second submechanisms), and 2 characters identify the object/product/substance (the first character identifying the category and the second the class, offering a significant expansion to the number of objects/substances capable of being captured in ICD-11 compared with ICD-10).

The introduction of uniformity in the code structure represents a departure from ICD-10. However, the benefits of increased specificity, comparability across use cases, and ability to use the classification in a multidimensional format outweigh the challenges of such a change.

Capture all mechanisms and objects/substances for all intents. As illustrated previously, the majority of codes in

ICD-10 for the external causes chapter are allocated to the Accidents intent block, with limited specificity of mechanisms and objects for all other intents. Our Topic Advisory Group proposes to use a consecutive series of designators at the start of the code string to identify the main type of intent, with the same mechanism/object concepts replicated within each intent block. Doing so will enable easy extraction and exploration of mechanisms/objects causing injury across all intents by removing the initial intent designator, allowing expansion of mechanisms/objects/substances for all intents uniformly.

Revise intent values. The intent dimension should be revised to address known ICD-10 limitations and criticisms, as follows:

- The ''Accident'' value should be revised to a concept such as ''Unintentional Cause.'' ''Accident'' denotes a sense of inevitability, whereas ''Unintentional Cause'' alludes to a more preventable action (10).
- An intent value of ''Pending Investigation'' should be introduced for injury-related deaths. Coroner/medical examiner processes can often take longer than the deadlines imposed on mortality coding agencies to produce cause-of-death statistics. Consequently, ICD-10 traditions result in preemptory coding to intent blocks that may not reflect the cause of death ultimately found. Providing a ''holding bay'' code to enable identification of injury-related deaths still undergoing investigation at the time of coding ensures that cases are not prematurely misclassified.
- For those cases assigned to the intent chapter of ''Intentional Self-Harm,'' it is proposed that an optional dimension for coding also would be to identify what the intended result of the self-harming behavior was, if known.

Provide a separate code block to capture place and activity. A separate code block for place (similar to the approach used in clinical modifications of the external causes chapter) will increase this dimension's specificity. This will be a ''code also'' dimension used with all core external causes codes. Similarly, a separate code block for activity in a ''code also'' format as well as an expansion of the scope of activities represented will be introduced in ICD-11.

Expansion of both place and activity dimensions will allow for much greater precision to identify and distinguish the location where injury events occur (e.g., events occurring in hospital compared with in the community), as well as the activities the person was undertaking at the time the injury happened (e.g., the type of sport/work engaged in at the time of the event).

Expand complications of care codes. To capture mechanisms relevant to both iatrogenic and noniatrogenic injuries, we propose that a specific designator (such as that used to identify different intents) be used to identify the block of codes associated with medical/surgical complications, which will provide far greater ''space'' to capture specific elements of concern. This will expand upon, and better integrate, complication of care codes with the wider classification. In addition, some mechanism/object blocks will still be dedicated to capturing the unique iatrogenic mechanisms/objects that do not logically fit with general mechanisms/objects (e.g., failure of sterile precautions, failure of dosage, contaminated medical/biologic substance, and object codes referring to specific medical devices). There is a special Topic Advisory Group in the ICD-11 revision process to address patient safety issues.

Expand legal intervention/war operation codes. Similar to the approach for complication of medical/surgical care, we propose to expand the capture of these intent dimensions through the ability to have more mechanism concepts associated with them in the revised structure. ICD-10 has a limited number of codes for legal interventions (8 unique codes) and operations of war (10 unique codes). ICD-11 will greatly expand the number of codes to describe legal-/war-related incidents (enabling capture of the same level of detail with regard to mechanisms and objects as for other ''intents''), which will significantly enhance the specificity of codes available to describe such incidents.

Change the transport block for greater uniformity. In keeping with the broader code structure regularization, the transport code block will be modified for greater uniformity. We propose removing the collision/noncollision concept because, with more specific information about the counterpart captured in the revised code structure, this information may be potentially superfluous. We also propose better integration of the place dimension, and, with place codes assigned more routinely, the concept of traffic/nontraffic may also be superfluous and removable from the core external cause code structure.

Improve capture of maltreatment. Maltreatment syndromes and related matters should be redefined in ICD-11 to reflect maltreatment by both commission and omission. ''Maltreatment,'' in ICD-10, includes both some actions that necessarily involve the intentional harm of one person by another (e.g., physical abuse, sexual abuse) and others where intent to harm is not necessarily present (e.g., ''neglect''). Revising maltreatment mechanisms and differentiating between the different maltreatment ''types'' will improve data capture in this domain.

Introduce optional additional dimensions. Optional dimensions, using the remaining unused code ranges in the chapter, are proposed to help improve data capture on matters relevant to particular use cases. Examples of these optional dimensions include Alcohol or drug involvement categories, Risk factors, Countermeasures/protective factors, and Event context. ICD codes have traditionally been confined to capture a grossly simplified representation of an injury event. To inform injury prevention, the proposed revision will introduce a broader range of concepts into the external cause chapter to allow for systematic capture and representation of core dimensions necessary for a more complete understanding of injury events.

Revise the index, rules, and guidelines. In light of the external causes chapter restructure, a critical review of the external causes of injury index, rules, and guidelines is also required in ICD-11. ICD-10 is deficient in this regard in a number of ways:

- It offers limited guidance for coders regarding interpretation of relevant documentation, use of the injury index, and subsequent assignment of external causes codes.

- Notes on inclusions and exclusions are inadequate when faced with ambiguous documentation.
- If multiple mechanisms are implicated, the index is incomplete with regard to identifying the preferred mechanism for coding.
- The index often does not take into account social/cultural/language differences in describing external causes.

Implications of recommended changes

The proposed ICD-11 restructure creates 1) a more uniform and standardized code structure and 2) largely comparable intent and mechanism values from ICD-10 to ICD-11. Mapping between ICD-10 and ICD-11 is facilitated through the proposed uniform code structure. Since intent/mechanism is easily identifiable because of designated code string positions, this change allows easy grouping to reporting levels recommended by WHO (i.e., Special Tabulation Lists) and the International Collaborative Effort on Injury Statistics (i.e., external causes matrix).

This revised structure will have a limited impact on the widely used Special Tabulation lists because their broad groupings of intent (accidents, intentional self-harm, assault) and high-level mechanisms (transport, falls, drowning and submersion, poisonings, and noxious substance exposure) will be easy to aggregate and capture.

To facilitate national and international comparability of injury statistics, we are developing the ICD-11 external causes of injury matrix in tandem with the chapter revision. The ICD-10 external causes of injury matrix was released in 2001, several years after the revision was in effect. Our goal for the ICD-11 matrix is to retain comparability with the ICD-10 and ICD-9 external causes matrices. However, while aiming to be as consistent as possible with previous revisions and matrices, we recognize that there are mechanism categories in the ICD-9 and ICD-10 external causes matrices that are not fully satisfactory in terms of homogeneity of concepts. Therefore, improvement rather than consistency will ultimately better serve injury prevention activities. In particular, several ICD-10 matrix categories need revising, namely, natural and environmental, struck by and/or against, cut or pierce, and machinery. In addition, the ''other and unspecified'' category could possibly be disaggregated into more meaningful mechanism categories.

CONCLUSIONS AND IMPLICATIONS

It is important to reiterate that the ICD is one of the most vital epidemiologic tools and enables storage and retrieval of health data over time and place for core national and international mortality and morbidity statistics. Revision of such a critical tool requires transparency and documentation to ensure that changes made to the classification system are recorded comprehensively for future reference. As such, this paper has outlined the history, structure, and deficiencies of external causes in ICD, approaches to managing these deficiencies, and the ICD-11 revision processes and external cause proposals to date. It is anticipated that through improved capture of external cause concepts in ICD-11, a stronger evidence base will be available to inform injury prevention and policy initiatives to ultimately contribute to a reduction in injury morbidity and mortality, a core global health concern.

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