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Title: Classifying External Causes of Injury: History, Current Approaches and Future Directions for the International Classification of Diseases

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Classifying External Causes of Injury: History, Current Approaches and Future Directions for the International Classification of Diseases

ABSTRACT

The International Classification of Diseases (ICD) is used to categorise diseases, injuries and external causes, and is a key epidemiological tool enabling the 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 remains current and work is now underway to develop the next revision, ICD-11. There have 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 external causes classification development and outline the external cause structure. Approaches to manage ICD-10 deficiencies are discussed and the ICD-11 revision approach regarding the development of, rationale for and implications of proposed changes to the chapter are outlined. 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.

Word count: 199

Abbreviations: APHA, American Public Health Association; ICD, International Statistical Classification of Diseases and Related Health Problems; ICD-10-AM, Australian clinical modification of the International Statistical Classification of Diseases and Related Health Problems, 10th edition; ICD-10-CA, Canadian clinical modification of the International Statistical Classification of Diseases and Related Health Problems, 10th edition; ICD-10-CM, U.S. clinical modification of the International Statistical Classification of Diseases and Related Health Problems, 10th edition; ICE, International Collaborative Effort; ICECI, International Classification of External Causes of Injury; ICEHS, Injury Control and Emergency Health Services; NCECI, NOMESCO Classification of External Causes of Injury; NCHS, National Center for Health Statistics; NEISS, National Electronic Injury Surveillance System; NOMESCO, Nordic Medico-Statistical Committee; RSG, Revision Steering Group; TAG, Topic Advisory Groups; WHO, World Health Organisation.

MeSH keywords: Accidents N06.850.135, Classification L01.100, Public Health N06.850, , Wounds and Injuries C26,

INTRODUCTION

The International Statistical Classification of Diseases and Related Health Problems (ICD) is the system used to categorise diseases, injuries and external causes of injuries for compilation and comparison of morbidity and mortality data internationally (1). The ICD is a key epidemiological tool enabling the storage and retrieval of data from health and vital records over time and place to produce core national and international statistics. The World Health Organisation (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 twentieth century the ICD has been revised about once every ten years, except for the nearly twenty year interval between the last two revisions, ICD-9 and ICD-10 (3). Work is underway to develop the next revision, ICD-11. The ICD is updated periodically to ensure 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 maintains consistency with ICD-10 to enable comparability over time, whilst 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. There 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 ICD-6 external causes chapter, for another 'bold attack' on the known deficits of the ICD for external causes(4). In 1982, preceding the introduction of ICD-10, Susan Baker stated:

“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.” (p. 201) (5).

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

In this paper, we provide a history of external causes of injury classification development and summarise 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 summarise 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 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 (2000) described the evolution of ICD external causes classification (7), and the core points are summarised below:

- In the mid-nineteenth 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 standardisation of classification and his approach to conceptualising and coding external causes is still recognisable in the ICD. He established the importance of physical and chemical forces resulting in “violent deaths or diseases”, by constituting these as one of the five 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. While not termed ICD until later, this was the basis for the numbering of revisions of the ICD.
- The 6th revision of the ICD (adopted in 1948; the first published under the auspices of the 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 this occurred (external causes) were divided into distinct sections. This distinction has persisted (7).
- Changes since the 6th revision largely comprise 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 8th revision for “Injury undetermined whether accidentally or purposely inflicted.”
- In ICD-6 through ICD-8, 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 which 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, and this 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. There are several dimensions required for complete capture of an external cause. The ICD-10 core code at three 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 three 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 the 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 pre-coordination. The rules and guidelines for selecting the underlying cause are found in the second of the three ICD-10 volumes (8). The other two 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 summarised as: *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 coding for morbidity episodes is done, then the process can be summarised as: *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: *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 as these can inform revisions to ICD-11. ICD-10 changed to an alphanumeric system from the primarily numeric system of ICD-9. This enabled a large expansion in the number of codes, allowing for increased definitional precision of most external causes of injury and diseases (though this precision was not utilised 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 (ie accidental, intentional self harm, assault etc). 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 external causes code assignment. Codes for complications of medical and surgical care were removed from unintentional or accidental injuries and included as a separate block. Table 1 summarises the changes between ICD-9 and ICD-10.

INSERT TABLE 1 HERE

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. This 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 pre-coordinated, as a way of embedding the required core external causes dimensions in single codes. However, to ensure the usability of the classification internationally and ensure codes do not become unwieldy for use in lower resourced settings, there has also traditionally been a limit to the number and format of characters allowable in the code string. This limits the amount of information by enforcing a cap on the number of concepts which can be captured in the code, which can impact on the quality of the external cause classification.

Table 2 provides a summary of 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, though place does form part of the complete ICD-10 external causes code and activity is an optional dimension. The same ten 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 which 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, sub-blocks 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, similar mechanisms to those which 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 italicised 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 (eg 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.

INSERT TABLE 2 HERE

Problems with 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 cause chapter

significantly simplifies injury dimensions to core phenomena deemed to be important by classification developers. A central purpose of the external causes of injury chapter is to capture information to inform injury prevention initiatives (9). 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 (eg work-related, during sporting activity). The system should also allow for aggregation of these elements for comparative purposes over time, place and population sub-groups. If the ICD does not satisfy these injury prevention requirements there is a considerable risk that a proliferation of alternative classification systems may occur, 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 a review of recent published literature was conducted. This 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 revision of ICD to the 11th edition were also compiled. Concerns raised in the various sources are summarised 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 only ever be 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 due to limitations of the ICD system.

Insert Table 3 Here

Approaches to Dealing with ICD-10 External Causes Deficiencies

In response to identified deficiencies there have been a number of approaches by data collectors and users 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, the 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. As 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 the aggregation and presentation of ICD coded external causes of injury data, developed specifically to facilitate comparability in the presentation of injury statistics. The matrix is a two-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 were jointly developed by the Injury Control and Emergency Health Services (ICEHS) section of the US American Public Health Association (APHA), the International Collaborative Effort (ICE) on Injury Statistics (12), and the US National Center for Health Statistics (NCHS). 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 NCHS website (12, 14).

Clinical Modifications of the ICD-10: Some countries have expanded on the base ICD system to provide more comprehensive morbidity coding. These expansions are termed clinical modifications and aim to enhance country specific public health surveillance and hospital utilisation data. In addition, the Australian clinical modification (ICD-10-AM) has been used for special mortality collections (eg Australian State/Territory child death review teams) to allow for increased specificity as well as being used for mortality coding in New Zealand (15). Jette (3) describes 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 ICD-10-CM (developed in the USA), ICD-10-CA (developed in Canada) and the ICD-10-AM.

Harrison et al (16) describe 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 described in this publication. Changes to 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).

ICD-9-CM is still used in US hospitals and external causes chapter changes are made annually via the Coordination and Maintenance committee (18). ICD-10-CM is developed and will be used for morbidity coding in the US from 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 NCHS website (19).

*Alternative Classification Systems:**International Classification of External Causes of Injury*

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.

The International Classification of External Causes of Injury (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 pre-coordinated code structure as in the ICD-10. ICECI is a Related Classification in the World Health Organization's Family of International Classifications (WHO-FIC) (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 seen as 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: emergency departments, clinics, in-patient hospital settings; for ad hoc studies/surveys; and in specialised mortality registration systems. The main identified uses are the US National Electronic Injury Surveillance System (NEISS)-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).

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 (NCECI) (30). This was developed for monitoring emergency room patients and is now in its 4th revision. NCECI is not a WHO-FIC 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 NCECI 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 for 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, 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 website (2).

A Revision Steering Group (RSG) oversees the process, with Topic Advisory Groups (TAGs) responsible for addressing content-specific domains (for example, internal medicine, dermatology, mental health, injuries and external causes). Content-specific TAGs are responsible for reviewing the ICD-10, identifying deficits, and documenting suggested changes in an on-line collaborative authoring platform (described in detail in a recent paper

by its Stanford developers (31)). Several cross sectional TAGs 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 summarised 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 the coding of 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 due to the use of automated coding systems, as in previous revisions, any mortality version of the classification needs to enable the selection and assignment of a single underlying cause of death code. 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 healthcare settings, collection and dissemination of injury morbidity data for national and sub-national priority setting, patient safety/quality of care indicators and identification of iatrogenic injury causes,

and to facilitate comparison of international injury morbidity trends. The morbidity use case is less constrained by the need for a single external cause code, as many hospital information systems are designed to capture multiple codes describing diagnoses, co-morbid conditions, procedures and external causes. If systems already have multiple fields for each patient, the 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 standardise 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, eg 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 TAG has focussed on four 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 a 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 pre-coordinated 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 pre-coordinated external causes code list (capturing several external cause dimensions in the one code, using a standardised uniform code structure).

At the time of this going to press, the revision process is still underway 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 these 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

Uniform Code Structure: The most critical recommendation is for a more uniform, regularized code structure for external causes codes. This should allow ICD-11 external causes to function in both pre-coordinated (i.e. for underlying cause of death coding) and multi-dimensional modular fashion (i.e. for morbidity, research and lower resourced setting uses). Each of the core dimensions (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 one character identifies intent, two characters identify mechanism (the first character identifying broad mechanisms and the second sub-mechanisms), and two 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 to ICD-10).

The introduction of uniformity in the code structure represents a departure from ICD-10 but 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 TAG 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. This will enable the easy extraction and exploration of mechanisms/objects causing injury across all intents by removal of the initial intent designator. This will allow 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:

- The ‘Accident’ value should be revised to a concept such as ‘Unintentional Cause’. ‘Accident’ denotes a sense of inevitability, while ‘Unintentional Cause’ alludes to a more preventable action (10).

- An intent value of ‘Pending Investigation’ should be introduced for injury-related deaths. Coronial/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 pre-emptory coding to intent blocks which 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 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 behaviour 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 to both place and activity dimensions will allow for much greater precision in ICD-11 to identify and distinguish the location where injury events occur (for example, events occurring in hospital compared to in the community), as well as the activities the person was undertaking at the time the injury happened (for example, the type of sport/work they were engaged in at the time of the event).

Expand Complications of Care Codes: To capture mechanisms relevant to both iatrogenic and non-iatrogenic injuries we propose a specific designator (such as that used to identify different intents) is 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, there will still be some mechanism/object blocks dedicated to capturing the unique iatrogenic mechanisms/objects that do not logically fit with general mechanisms/objects (for example, failure of sterile precautions, failure of dosage, contaminated medical/biological 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 (eight unique codes) and operations of war (ten 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 regards to mechanisms and objects as for other ‘intents’), which will significantly enhance the specificity of codes available to describe such incidents.

Change Transport Block for Greater Uniformity: In keeping with the broader code structure regularisation, the transport code block will be modified for greater uniformity. We propose removing the collision/noncollision concept as, with more specific information about the counterpart captured in the revised code structure, this information may be potentially superfluous. We also propose a 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, 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 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 required also in ICD-11. ICD-10 is deficient in this regard in a number of ways:

- Offers limited guidance for coders regarding the 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 regards 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 a) a more uniform and standardised code structure, and b) 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. As intent/mechanism is easily identifiable due to designated code string positions, this allows easy grouping to reporting levels recommended by WHO (i.e. Special Tabulation Lists) and the ICE on Injury Statistics (i.e. external causes matrix).

This revised structure will have limited impact on the widely used Special Tabulation lists as 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 under the revised ICD-11 structure.

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, whilst aiming to be as consistent as possible with previous revisions and matrices we have recognized 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 epidemiological 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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Table 1. Changes to External Causes of Injury Chapter from ICD-9 to ICD-10.

Level of Change	Details
<i>Terminology changes</i>	
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’.
<i>Structural changes</i>	
Coding system	A primarily numeric system changed to alphanumeric. External causes chapter changed from the E800-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.
<i>Broad code block changes</i>	
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) while in ICD-9 transport accidents were grouped by vehicle type
<i>Specific code changes</i>	
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 to 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 ICD-9
Firearms	Codes are less specific in ICD-10 than ICD-9
Poisonings	Some changes in the classification of deaths due to accidental poisoning under ICD-9 to mental and behavioural 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.
<i>Rules / guideline changes</i>	
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”.

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

INTENT	MECHANISM	OBJECT/SUBSTANCE
V00-X59 Accidents	V00-V99 Transport	Injured person/counterpart mode of transport, traffic/non traffic, injured person role
	W00-W19 Falls	Snow/ice, Conveyances, furniture, structures
	W20-W49 Exposure to inanimate mechanical forces	Sport equip, sharp object, machinery, firearm, pressurised 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 substance)
	X50-X57 Overexertion, travel and privation	Food, water
	X58-X59 Exposure to other and unspecified factors	Nil
X60-X84 Intentional self-harm	X60-X69 <i>Poisoning by/exposure to noxious substances</i>	Class of substance
	X70 <i>Threats to breathing</i>	Nil
	X71 <i>Drowning and submersion</i>	Nil
	X72-X75, X78-X79 <i>Exposure to inanimate mechanical forces</i>	Firearm, sharp object , blunt object
	X76-X77 <i>Exposure to smoke, fire and flames</i>	Nil
	X80 <i>Falls</i>	Nil
	X81-X82 <i>Transport</i>	Motor vehicle
	X83-X84 <i>Other and unspecified means</i>	Nil
X85-Y09 Assault	X85-X90 <i>Poisoning by/exposure to noxious substances</i>	Class of substance
	X91 <i>Threats to breathing</i>	Nil
	X92 <i>Drowning and submersion</i>	Nil
	X93-X96, X99-Y00 <i>Exposure to inanimate mechanical forces</i>	Firearm, sharp object , blunt object
	X97-X98 <i>Exposure to smoke, fire and flames</i>	Nil
	Y01 <i>Falls</i>	Nil
	Y02-Y03 <i>Transport</i>	Motor vehicle
	Y04-Y05, Y07 <i>Exposure to animate mechanical forces</i>	Person
	Y06 <i>Privation</i>	Nil
	Y08-Y09 <i>Other and unspecified means</i>	Nil

Table 2. ICD-10 Structure and Content of Core Dimensions for Main Intent Blocks (continued)

INTENT	MECHANISM	OBJECT/SUBSTANCE
Y10-Y34 Event of undetermined intent	Y10-Y19 <i>Poisoning by/exposure to noxious substances</i>	Class of substance
	Y20 <i>Threats to breathing</i>	Nil
	Y21 <i>Drowning and submersion</i>	Nil
	Y22-Y25, Y28-Y29 <i>Exposure to inanimate mechanical forces</i>	Firearm, sharp object , blunt object
	Y26-Y27 <i>Exposure to smoke, fire and flames</i>	Nil
	Y30 <i>Falls</i>	Nil
	Y31-Y32 <i>Transport</i>	Motor vehicle
	Y33-Y34 <i>Other and unspecified means</i>	Nil
Y35-Y36 Legal interventions and operations of war	Y35.0-Y35.4, Y36.0-Y36.5 <i>Exposure to inanimate mechanical forces</i>	Firearm, explosives, sharp object , blunt object, gas, weapons
	Y35.2, Y36.6 <i>Poisoning by/exposure to noxious substances</i>	Gas, Biological weapons
	Y35.0-Y35.1, Y35.3-Y35.4, Y36.7-Y36.9 <i>Other and unspecified means</i>	Nil
Y40-Y84 Complications of medical and surgical care	Y40-Y59 <i>Poisoning by/exposure to noxious substances</i>	Class of substance
	Y60-Y61 <i>Exposure to inanimate mechanical forces</i>	Nil (type of procedure being performed)
	Y62-Y64, Y66 <i>Failure sterile precautions, dosage, contaminated med/biol substance</i>	Blood, fluid, radiation (+type of procedure performed)
	Y70-Y84 <i>Medical devices/Surgical procedures associated with adverse effects</i>	Medical specialty class of device/type of procedure
	Y65-Y69 <i>Other and unspecified means</i>	Nil

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

Limitation	Description
<i>Terminology/ Definitional issues</i>	
Terminology	The term 'Accidental' has been criticised, with 'Unintentional' typically used in the injury research community (10).
Definitions	Lack of definitions of external causes terms and selection criteria (barring transport codes).
<i>Structural issues</i>	
Precedence of coding of intent, and pre-coordination 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: <ul style="list-style-type: none"> • 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' is 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'.
Non-injury diagnoses requiring external causes	Non-injury 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 non-injury cases and the diagnoses codes are required to ensure accurate case selection (36).
<i>Broad code block issues</i>	
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).
<i>Specific code issues</i>	
Loss of specificity from earlier versions	Certain codes had decreases 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).
<i>Rules / guidelines affecting external causes</i>	
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 utilise 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).

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

Limitation	Description
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 non-fall 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 impact coding quality and resultant mortality data (49-51).
<i>Quality of external causes coding</i>	
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.