# Revision of the International Classification of Diseases to include standardized descriptions of multiple injuries and injury severity

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## Introduction

The International Classification of Diseases (ICD) is widely used as a source of mortality statistics. However, two major difficulties arise when recording, presenting and analysing injury data using this diagnosis classification. First, due to the absence of standardized methods for describing multiple injuries, they are described in various ways in mortality and morbidity statistics. For example, designating the most severe injuries as the primary injuries or categorizing multiple injuries as such without further details.[1] Second, an increasing need to describe injury severity for case-mix groups has led to the introduction of various additional severity-scoring methods, as the ICD itself, as a diagnosis classification for mortality, does not consider severity. To avoid the costs of additional severity scoring, methods have been developed to convert administrative ICD-based diagnosis codes into severity scores using computer software or to calculate survival probability for each diagnosis code from patient data. However, these approaches have respective disadvantages due to the need to track software updates or the need for large data sets to calculate the probabilities.[2]

The World Health Organization[3] is currently advocating revision of the ICD to expand upon its largely administrative applications and allow more clinical uses. This provides an opportunity to address the issues associated with describing multiple pathologies and scoring the severity of injury data, which are also relevant to other non-injury diseases. In addition, a few low-income countries do not use the ICD or severity scores, even in the absence of vital registrations depending on periodical surveys,[3] thus the revision process should facilitate their adoption of standardized methods. Here we discuss how the revised ICD system could standardize the description of multiple injuries to provide accurate statistics, incorporate severity scores to avoid additional resource input, and facilitate utilization in countries where it is not currently in use.

## Describing multiple injuries

For mortality statistics, the one-dimensional principle of the ICD allows only one underlying cause of death to be selected and coded. The multi-dimensional phenomenon of multiple injury is thus usually reduced either to a single code reflecting the primary (most severe) injury or to one of a few multiple-injury codes, based upon an arbitrary decision.[1,4] Selecting the primary injury when filling in death certificates, or the underlying cause from among several injuries reported in death certificates, is also an arbitrary practice that reflects the certifier's or coder's perception of which pathology is the most important. Choosing just one code results in a loss of information on the other, unselected, pathologies, so the resultant statistics underestimate the significance of each injury and inadequately depict the interactions between them.[1] The limited number of multiple-injury codes included in the ICD cannot cover all possible patterns. For example, codes T00–T07 indicate injuries involving multiple body regions while S codes also include multiple injuries in the same body regions, (e.g. S52.7 indicates "multiple fractures of the forearm"). This arbitrariness, due to a lack of standardization, also applies to the presentation and analysis of morbidity statistics,[1] although not to the way that they are recorded because clinical modifications of the ICD require the coding of each injury, thereby superseding the multiple-injury codes.

The shortcomings of one-dimensional coding have led some countries to introduce multiple coding systems for mortality statistics, in which all causes mentioned on a death certificate are coded and reported.[4] It would be preferable to omit the multiple-injury codes from the revised ICD, and to code and record all injuries separately. This would allow all patients with a certain injury to be counted, even when it is not the primary injury, which is not the case with one-dimensional underlying-cause (or primary-injury) coding.[1] When presenting data on multiple injuries, instead of simply listing all injuries sustained, it might be preferable to use two-dimensional coding that reflects the important attributes of the nature of the injury and the affected body region to characterize an individual's injuries.

Proposed methods to describe multiple injuries while presenting statistics in a standardized way include the multiple injury profile, which combines information on the anatomy and the nature of the injury, using a body-region by injury-nature matrix.[1] Each injury falls into one of the cells in the matrix. The multiple injury profile can summarize all of the individual injuries in one patient using cell combinations. The granularity of the categorizations used in the matrix can be changed by subdividing or collapsing the categories as needed. An abridged version of the matrix can be used as a shortlist in countries where the full list of the ICD is not used. By contrast, the matrix can be used as a supplement, in conjunction with listing all of the injuries to give complete descriptions in countries where multiple coding is done.

Multiple coding using standardized methods of presenting multiple pathologies, if applied to the whole ICD, would allow more accurate descriptions of each pathology and the interactions both

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Table 1. **Methods for scoring severity of injuries**[a]

| Severity scores | Definition | Characteristics | Required resources |
|---|---|---|---|
| Abbreviated injury scale (AIS) | An injury categorization with severity scores assigned to each injury category. Injuries are rated from 1 (minor) to 6 (fatal). | – Not designed for survival prediction.<br>– Determined based on expert consensus. | – Duplicate coding or computer software (ICDMAP) to obtain AIS severity scores from ICD codes. |
| Injury severity score (ISS) | Indicates overall severity for a patient with multiple injuries. ISS is a sum of the square of the highest AIS severity scores of the three most severely injured body regions (from a choice of six body regions).<br>$ISS = AIS_1^2 + AIS_2^2 + AIS_3^2$ | – Does not consider physiological parameters.<br>– Equal weighting given to each body region.<br>– Does not account for multiple injuries in the same body region. | – AIS severity score |
| Revised trauma score (RTS) | Consists of physiological parameters independent of anatomical injury scores.<br>$RTS = 0.9364 \times GCS + 0.7326 \times SBP + 0.2908 \times RR$[b] | – Physiological parameters are time-sensitive. | – Patient data and statistical software to calculate country-specific coefficients. |
| Trauma and injury severity score (TRISS) | A combination of an anatomical measure (ISS), physiological measure (RTS) and patient ability to withstand injury severity (age) by type of injury (blunt/penetrating). Probability of survival (Ps) is determined using a logistic regression model.<br>$Logit\ (Ps) = \beta_0 + \beta_1 \times RTS + \beta_2 \times ISS + \beta_3 \times age$[b] | – Widely used in outcome studies because of its good predictive ability. | – Availability of AIS severity score.<br>– Patient data and statistical software to calculate country-specific coefficients.<br>– Computer software to calculate the score because of its mathematical complexity. |
| ICD-based injury severity score (ICISS) | A multiplicative prediction model with an assumption that all injuries contribute to the overall severity. The SRR for each code is empirically derived from the patient data. To obtain ICISS, SRRs of all injuries are multiplied.<br>$ICISS = SRR_{inj1} \times SRR_{inj2} \times SRR_{inj3} \times SRR_{injn}$ | – Directly derived from ICD or ICD-CM codes. – Predictive ability is equal to, or better than, that of the TRISS. | – Large patient data set.<br>– Computer software might be required to calculate each patient's score due to large number of codes |
| Matrix-based method | In a body-region by injury-nature matrix (such as the Barell matrix), the proportions of survival and approximated AIS score are calculated based on data for each cell. These values are used in the same way as ICISS and AIS-based indices. | – Relatively easy to handle due to diminished number of categories compared with other methods. | – Patient data set (not necessarily a large one) and statistical software to calculate country-specific values.<br>– AIS severity score if approximated severity scores are determined. |

GCS, Glasgow Coma Score; ICD, International Classification of Diseases; ICD-CM, International Classification of Diseases-Clinical Modification; RR, respiratory rate; SBP, systolic blood pressure; SRR, survival risk ratio.

[a] This is not a comprehensive list of injury scores, but rather shows typical and popular indices to indicate their relationships with the ICD codes and required resources.

[b] Coded values are used for Glasgow Coma Score, systolic blood pressure, respiratory rate and age.

within and between specific types of injury or internal cause.[1,4] This would also help to clarify how underlying ailments contribute to the impact of injuries in ageing societies.

## Describing injury severity

Various methods have been developed to score injury severity (Table 1).[5] The abbreviated injury scale (AIS) describes the anatomical injury severity using consensus-based scores determined by experts. The revised trauma score (RTS) is based on physiological parameters independent of injury diagnoses. The injury severity score (ISS) consists of the square of the highest AIS scores in the three most severely injured body regions. The trauma and injury severity score (TRISS) predicts survival probabilities using logistic regression modelling that employs the ISS, RTS, age and injury mechanism as predictors. AIS-based methods, such as TRISS, are widely used because of their suitability and accuracy based on ample research findings. However, duplicate coding for injury diagnosis and severity carries additional costs in terms of human resources and training requirements to ensure accuracy, which is unaffordable in resource-constrained settings.[2]

To avoid the additional costs associated with duplicate coding, attempts have been made to assign a severity score to each ICD-based diagnosis. One successful example is a method that derives AIS severity scores from ICD-9 codes using computer software (ICDMAP).[2] Although this is a validated tool, it also carries additional costs, albeit smaller ones than those associated with duplicate coding, and it notably fails to update using newer versions of the ICD and AIS, resulting in variability in the versions used in case-mix grouping methods.[2]

Another example is the ICD-based injury severity score (ICISS), which assigns an empirically derived severity score to each ICD code.[2,5] Survival probabilities, called survival risk ratios (SRRs), are calculated for each code based on patient data (Table 1). The ICISS is a promising measure that performs as well as, or better than, AIS-based methods; however, it has some shortcomings that might hinder its use in low-income countries, particularly those with small populations. Large data sets are required to avoid large fluctuations occurring in the SRRs for rare injuries. Also, SRRs might differ across countries and over time, depending on health-care systems and improvements in treatment, thereby requiring countries to calculate and update their own data sets.[2]

Whereas code conversion and the ICISS operate outside the ICD framework and do not modify the diagnosis codes, an alternative approach would

be to integrate consensus-based severity scores into the ICD. The revised ICD is expected to have wider coverage, including morbidity statistics and case-mix groupings.[3] Integrating an AIS system into the revised ICD as a clinical modification or expansion would remove the need for duplicate coding or code conversion (and associated software updates). This would be facilitated by recent improvements in the compatibility between the ICD and the AIS.

None of the above-mentioned severity-scoring methods can be used in countries where a shortlist of ICD codes is required. The matrix-based approach can, however, be applied if the predominant AIS severity scores (because more than one code can fall in one cell) or ICISS-type survival probabilities are determined for each of the matrix cells based on empirical data.[6] Assigning a consensus-based approximate severity score to each cell is also possible. This abridged method, with diminished diagnosis categories and the flexibility to handle both AIS-type and ICISS-type indices, can be used to create a short morbidity list with severity scores for resource-constrained settings.

## Conclusion

The ICD revision process presents a good opportunity to standardize the description of multiple injuries and injury severities regardless of resource availabilities. We suggest that the revised ICD should have a multiple coding framework for individual pathologies, deactivating multiple-injury codes, so as to consider the significance of each injury or pathology and their interactions. The ICD should also incorporate consensus-based severity scores in its clinical modifications, so that case-mix groupings can be considered in resource-constrained settings without requiring duplicate coding or code-conversion software, while data-derived severity indices can be employed in less constrained settings. Matrix-based methods should also be considered, as they provide a simple basis for multiple injury description and case-mix groupings using fewer categories, making them suitable for countries where a shortlist of ICD codes is needed. ■

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