Original Article

Bridging classification for injury diagnoses that can be converted to both the International Classification of Diseases and the Abbreviated Injury Scale

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Background: The International Statistical Classification of Diseases and Related Health Problems (ICD) is currently undergoing a revision process to develop the Eleventh Revision (ICD-11), but substantial modification of chapter 19 has not been proposed despite its known problems in describing injury severity and multiple injuries. Many facilities treating trauma patients perform duplicate coding for trauma diagnoses using two different classification systems, the ICD for administrative purposes and the Abbreviated Injury Scale (AIS) for trauma registry, because unambiguous conversion of codes between the ICD and AIS is not always possible due to structural differences.

Aim: We developed a new bridging classification system which can be unambiguously converted to both ICD and AIS.

Methods and Results: The bridging classification adopted multidimensional coding and addressed differences in granularity and classification boundaries by adopting the more detailed categorizations whenever the granularity and classification boundaries differed between the ICD and AIS. Then we showed that the bridging classification codes could unambiguously converted to both ICD and AIS.

Conclusion: Once injuries are coded using the bridging classification, the ICD and AIS codes are readily available. Integrating the new bridging classification into the ICD-11, possibly as a clinical modification, would eliminate the necessity of complicated procedures for code conversion and duplicate coding, and benefit users by building on the strengths of both the ICD and AIS.

Key words: Abbreviated Injury Scale, duplicate coding, ICD-10, Injury classification, multiple injuries, severity scoring

INTRODUCTION

THE INTERNATIONAL STATISTICAL Classification of Diseases and Related Health Problems (ICD) is currently undergoing a revision process from the Tenth Revision (ICD-10) to the Eleventh Revision (ICD-11), so the beta draft of ICD-11 is now open for field testing.¹ As the World Health

Organization (WHO) advocates the expansion of ICD coverage of mortality statistics for administrative, clinical, and research purposes,² several varied modifications can be seen in the draft. However, no substantial modifications have been carried out to chapter 19, which covers the nature of injuries. This is despite the problems associated with the chapter, particularly in the description of multiple injuries and severities.

Trauma diagnoses in many facilities treating trauma patients use two different classification systems, the Abbreviated Injury Scale (AIS) and the ICD.^{3–5} The ICD and its clinical modifications, as the international standard of disease and injury classification, are usually used for administrative purposes such as hospital patient data systems and medical cost reimbursements. However, as a classification system of mortality statistics, the ICD does not have the function to describe disease or injury severity; this nature is inherited by its modifications. In addition, the ICD adopts a unidimensional coding principle, in which only one code is used even for describing multiple injuries, resulting in loss of

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information. For example, only the primary diagnosis might be included, or a vague classification such as “multiple injury” may be used.^{6,7}

By contrast, the AIS with its multidimensional principle is able to allocate a code and severity score to each injury, so is widely used for trauma registries. Unfortunately, due to the different structures of the two systems, unambiguous conversion of codes between the ICD and AIS, in either direction, is not always possible, necessitating duplicate coding.

As accurate coding requires skilled staff, duplicate coding doubles the intrinsically expensive cost of coding.^{5,8} To avoid such additional costs, various measures have been attempted with partial success. One is the use of computer software to convert ICD-based codes into AIS severity scores.⁹ Although this is a validated method, the software failed to keep up with the revisions of ICD and AIS.⁸ Another technique is to calculate the survival probability for each ICD or its clinical modification code based on empirical data, known as the ICD-based Injury Severity Score (ICISS).^{4,10} The ICISS is a promising method that can be used without AIS. However, allocating a probability value to each code including rare injuries requires a large dataset, and the values may differ between countries and over time.⁸ Therefore, each country should have its own values that they regularly update, but this can be difficult to achieve in low- and middle-income countries with small populations.⁸

Although the revision of the ICD provides a rare opportunity to address the above-mentioned issues, no such attempts have been made thus far. We therefore propose that the ICD and AIS should be combined to eliminate the need for duplicate coding or code conversion and to allow users to benefit from both systems. In this paper we show that it is possible to achieve this goal by developing a bridging classification system that can be unambiguously converted to both ICD and AIS; this effectively bypasses, instead of fully facing, the difficulties in direct conversion.

METHODS

Materials

WE DEVELOPED A new bridging classification system which can be unambiguously converted to both ICD-10 (S00–S99) and AIS 2005 Update 2008 (100099–856272). Excluded from the development were injuries in unspecified locations (T08–T14 in ICD and 910000–910800 and 914000–916000 in AIS), non-traumatic injuries, burns, and complications or sequelae of injuries (T15–T98 in ICD and 010000–080000 and 912000–912032 in AIS).

Both ICD and AIS combine information regarding injured body region and injury nature. In ICD, S codes indicate

injuries to single body regions and T codes indicate injuries to multiple or unspecified body regions. The first digits of the S codes indicate the body regions. The second digits indicate injury nature. The third (post dot) digits indicate the details of the injuries.

Of the 6-digit pre-dot codes in AIS, the first digits indicate the body region, the second digits indicate the anatomical structure (e.g., blood vessels and nerves), and the third to sixth digits indicate the injury details. The first post-dot digits indicate injury severity, and the second to fifth post-dot digits are localizers that indicate detailed injured locations.

Development of bridging classification

The bridging classification used the following strategies to assure its compatibility with ICD and AIS by addressing the issues that make unambiguous conversion between the ICD and AIS challenging. First, we addressed the difference between unidimensional and multidimensional coding. We applied multidimensional coding that allows recording of all injuries, following AIS coding; and when converting each code, the bridging classification suspended the multiple-injury codes in the ICD (SXX.7 indicating multiple injuries in the same body region and T00–T07 indicating injuries involving multiple body regions). The multidimensional ICD codes can then be converted into unidimensional multiple-injury codes.

Second, we addressed different granularity of categorization (one system has a more detailed categorization than the other) and different classification boundaries (e.g., one system has a more detailed anatomical categorization but a less detailed nature of injury categorization; one system lacks the corresponding specific categories to the other). The bridging classification adopted the more detailed categorizations whenever the granularity or classification boundaries differed between the ICD and AIS. If either the ICD or AIS lacks a corresponding specific category, the bridging classification adopted the existing category. In some such cases, we subdivided the adopted categories by reference to similar injuries to maintain categorization uniformity.

Third, the bridging classification adopted two methods of coding for pelvic fractures, as the ICD and AIS use completely different classification principles. One code indicated information on pelvic ring stability and the other indicated the location of the fracture or dislocation.

Finally, the bridging classification maintained multiple-injury codes for rib fractures following AIS. The rib cage rather than each rib was considered as a single unit of structure because its stability determines the injury severity. Therefore, multiple rib fractures were considered to present

different pathologies than a sum of the pathology of several single fractures.

Coding structure

The code structure of the bridging classification was determined as follows: the first digit indicated the body regions according to the ICD-10; the second digit indicated laterality (0 is indicated when there is no laterality); the third digit indicated the anatomical structure; the fourth and fifth digits indicated detailed locations and specific organs; the sixth and seventh digits indicated the nature of the injury; and the eighth (post dot) digit indicated the injury severity, ranging from 1 (minor) to 6 (major).

RESULTS

TABLE 1 SHOWS EXAMPLES of the bridging classification of upper extremity injuries (penetrating injury, contusion, and crush injury). For open wounds, the ICD provides a more detailed anatomical categorization whereas AIS has a more detailed categorization of injury nature (avulsion, laceration, and penetrating injury) and severity (minor, with tissue loss, and with blood loss). Therefore, the bridging classification adopted the anatomical categorization from the ICD and the categorization of injury nature from the AIS. In AIS, the elbow and upper arm below the shoulder are included in one category as “at or above elbow and below shoulder.” Although the localizer

Table 1. Examples of the bridging classification for injury diagnoses: upper extremity injuries (penetrating injury, contusion, and crush injury)

Bridging classification	ICD	AIS [†]
Penetrating injury of upper arm, NFS as to severity	S41.1 Open wound of upper arm	716014.1xx61 Penetrating injury at or above elbow, below shoulder, NFS as to severity
Superficial; minor		716015.1 xx61 superficial; minor
With tissue loss >25 cm ²		716016.2 xx61 with tissue loss >25 cm ²
With blood loss >20% by volume		716017.3 xx61 with blood loss >20% by volume
Penetrating injury of elbow, NFS as to severity	S51.0 Open wound of elbow	716014.1xx62 Penetrating injury at or above elbow, below shoulder, NFS as to severity
Superficial; minor		716015.1xx62 superficial; minor
With tissue loss >25 cm ²		716016.2xx62 with tissue loss >25 cm ²
With blood loss >20% by volume		716017.3xx62 with blood loss >20% by volume
Penetrating injury of forearm, NFS as to severity	S51.8 Open wound of other parts of forearm	716018.1xx63 Penetrating injury below elbow, at or above wrist, NFS as to severity
Superficial; minor		716019.1xx63 superficial; minor
With tissue loss >25 cm ²		716020.2xx63 with tissue loss >25 cm ²
Contusion of thumb without nail damage	S60.6 Contusion of finger(s) without damage to nail	710402.1 Skin/subcutaneous/muscle contusion; hematoma (upper extremity)
Contusion of finger(s) without nail damage	S60.1 Contusion of finger(s) with damage to nail	
Contusion of thumb with nail damage		
Contusion of finger(s) with nail damage	S60.2 Contusion of other parts of wrist and hand	
Contusion of wrist		
Contusion of hand		
Contusion of unspecified part of wrist and hand		
Crush injury to thumb	S67.0 Crushing injury of thumb and other finger(s)	713005.2 Crush injury to thumb
Crush injury to finger(s)		713006.1 Crush injury to non-thumb finger, single or multiple
Crush injury to wrist	S67.8 Crushing injury of other and unspecified parts of wrist and hand	713003.3 Crush injury below elbow, at or above wrist
Crush injury to hand		713004.2 Crush injury to hand, partial or complete

[†]First localizer (L1) and second localizer (L2) can follow the post-dot severity score. Both L1 and L2 are two-digit numbers: L1 indicates the side and aspect of an injury location (XX) and L2 indicates further specificity (e.g., 61 indicates upper arm, 62 elbow and 63 forearm). AIS, Abbreviated Injury Scale; NFS, not further specified; ICD, International Classification of Diseases and Related Health Problems.

Table 2. Examples of bridging classification for injury diagnoses: nerve injuries of the upper arm/shoulder (median nerve, radial nerve, and axillary nerve)

Bridging classification		ICD	AIS†
Description	Severity score		
Injury of median nerve at upper arm level, NFS	1	S44.1	730499.1 Median nerve NFS
Contusion	1	Injury of median nerve at upper arm level	730402.1 contusion
Laceration	2		730404.2 laceration
With motor loss	2		730406.2 with motor loss
Injury of radial nerve at upper arm level, NFS	1	S44.2	730699.1 Radial nerve NFS
Contusion	1	Injury of radial nerve at upper arm level	730602.1 contusion
Laceration	2		730604.2 laceration
With motor loss	2		730606.2 with motor loss
Injury of axillary nerve, NFS	(1)	S44.3	730099.9 Nerve injury in upper extremity NFS
Contusion	(1)	Injury of axillary nerve	
Laceration	(2)		
With motor loss	(2)		

†Although the Abbreviated Injury Scale (AIS) does not have specific codes for axillary nerve injuries, the new classification system can adopt the same injury severity scores as in other nerve injuries (in brackets). ICD, International Classification of Diseases and Related Health Problems; NFS, not further specified.

can differentiate between these body parts, it is not always used. However, the bridging classification explicitly differentiated between them following ICD. Likewise, the categorization of finger contusion adopted the injury nature from the ICD (with or without nail damage) and the anatomical categorization (thumb or non-thumb finger) used in crush injuries from the AIS (to maintain the uniformity of categorization).

Table 2 shows examples of the classification of nerve injuries in the upper arm/shoulder. Injuries to median and radial nerves have specific categories in both the ICD and AIS, but axillary nerve injury does not have a specific category in the AIS. The bridging classification adopted the category of axillary nerve injury according to the ICD, which was then subdivided by reference to median and radial nerves; and it adopted the same injury severity scores as other similar nerve injuries (shown in brackets). Codes for these categories of axillary nerve injuries in the bridging classification can then be converted to “injury of axillary nerve” in the ICD and “nerve injury in upper extremity not further specified” in the AIS.

Table 3 shows the classification of pelvic fractures that combined the two methods. The code for ring stability can then be converted to the AIS code and the code(s) for the fractured locations can be converted to the ICD code(s). For the fractured locations, two or more codes may be selected when there are multiple fractures. Table 4 shows the classification of rib fractures. The bridging classification used

multiple-injury codes indicating the number of fractures following AIS.

Table 5 shows an example of coding (with severities) for multiple injuries in a patient with conversion to the ICD and AIS codes. Two codes were allocated to the pelvic fracture according to ring stability and location of fracture. Multiple injuries were collapsed into a single multiple-injury code of T06 after allocating the code for each injury.

DISCUSSION

THIS PAPER SHOWS how it is possible to deal with the difficulties in direct conversion between the ICD and AIS using the new bridging classification system that we developed. The new codes can be unambiguously converted to both ICD and AIS codes, which means that once injuries are classified using the new classification, the ICD and AIS codes are readily available without the need for complicated algorithms. In this way, the bridging classification addressed not only the differences in categorization but also differences between the unidimensional and multidimensional coding principles of the two systems. Thus duplicate coding or code conversion would become unnecessary.

More importantly, it is possible to integrate the ICD-10 and AIS 2008 in the revised ICD-11 by incorporating the bridging classification in some way, for example, as a clinical modification. The compatibility of the new classification with the ICD-10 can assure the compatibility required

Table 3. Classification of pelvic fracture by pelvic stability and fracture location

Bridging classification [†]	AIS	ICD
<i>Pelvic ring stability → AIS</i>		
Pelvic ring fracture, posterior arch intact	856151.2	
Pelvic ring fracture, incomplete disruption of posterior arch, NFS	856161.3	
Blood loss ≤20% by volume	856163.4	
Blood loss >20% by volume	856164.5	
Pelvic ring fracture, complete disruption of posterior arch and pelvic floor, NFS	856171.4	
Blood loss ≤20% by volume	856172.4	
Blood loss >20% by volume	856173.5	
<i>Location of fracture(s) and dislocation(s)[‡] → ICD</i>		
Fracture of sacrum		S32.1
Fracture of coccyx		S32.2
Fracture of ilium		S32.3
Fracture of pubis		S32.5
Dislocation of sacroiliac joint		S33.2
Dislocation of sacrococcygeal joint		S33.2
Traumatic rupture of symphysis pubis		S33.4

[†]Two codes are selected for the new classification, one for pelvic ring stability and the other for location of fracture(s) and dislocation(s).

[‡]Fracture of acetabulum is separately described. AIS, Abbreviated Injury Scale; ICD, International Classification of Diseases and Related Health Problems; NFS, not further specified.

Table 4. Classification of rib fracture and flail chest

Bridging classification	ICD	AIS
Single rib fracture	S22.3 Fracture of rib	450201.1 Rib fracture without flail, one rib
Multiple rib fractures, NFS	S22.4	450210.2 Multiple rib fractures NFS
two ribs	Multiple fractures of ribs	450202.2 Rib fracture without flail, two ribs
≥3ribs		450203.3 ≥3 ribs
Rib fractures with flail chest, NFS	S22.5	450209.3 Rib fractures with flail NFS
Unilateral flail chest, NFS	Flail chest	450211.3 unilateral flail chest NFS
3–5 flail ribs		450212.3 3–5 flail ribs
>5 flail ribs		450213.4 >5 flail ribs
Bilateral flail chest		450214.5 bilateral flail chest

AIS, Abbreviated Injury Scale; ICD, International Classification of Diseases and Related Health Problems; NFS, not further specified.

between the ICD versions (between ICD-10 and -11); similarly, its compatibility with the AIS enables the use of AIS-based severity scoring. If survival probability for each code of the bridging classification is calculated based on patient data, both the ICISS method and AIS-based scoring can be used without duplicate coding, which would increase the users' options depending on their situations.

Integrating the two systems would provide benefits derived from the strength of both systems. The AIS is better

able to describe multiple injuries than the ICD, and AIS-based severity scoring is the most widely used method for casemix grouping.^{3,4} Trauma surgeons in such settings, who are familiar with the AIS, can continue to use AIS-based methods in the ICD-11 era. The ICD is the international standard of disease classification, most widely used for administrative purposes such as describing diagnoses, including injuries, for hospital patient records. All of these utilities can be inherited in the bridging classification.

Table 5. Example of coding for multiple injuries in a patient

Bridging classification		AIS code	ICD-10 code	
Code	Description			
0110224.2	Scalp laceration, major (right)	110604.2	S01.0	T06.8
3061804.3	Liver contusion, subcapsular, >50% surface area	541814.3	S36.1	
3057820.4	Pelvic ring fracture, incomplete disruption of posterior arch,	856163.4	S32.3	
3157320†	blood loss ≤20% by volume with fracture of ilium (right)			
4154100.2	Scapula body fracture (right)	750951.2	S42.1	
4110442.1	Penetrating injury at upper arm (right), superficial	716015.1	S41.1	
5110242.1	Penetrating injury at elbow (right), superficial	716015.1	S51.0	

†Indicates location of the fracture.

To enjoy these benefits, the integration should be permanent and complete. Partial integration would result in the same failures encountered by the conversion software. ICD-MAP is a widely used software to derive AIS severity scores from ICD-9CM codes.⁹ Although validated, it did not keep up with the revisions of ICD and AIS, which reduced its value. In the same way, if the bridging classification becomes independent of the ICD or AIS, it would be challenging to keep pace with changes in either system. However, if integrated completely, all systems should change en bloc at the time of revision.

Furthermore, integration of the two systems would also benefit the standardization of mortality and morbidity statistics in resource-constrained countries where neither ICD nor AIS is used for disease or injury classification. Such countries might use a short list of ICD or even lack a vital registration system. Abridged versions of the ICD–AIS combination may serve as a useful shortlist of injury classification with flexible options of ICISS-based and AIS-based severity scoring methods, which would facilitate the adoption of standardized methods.^{5,11}

CONCLUSIONS

WE BELIEVE THE current process of ICD revision provides a good opportunity to address the difficulties that we face in using two classification systems. The bridging classification between the ICD and AIS is one option to achieve this by integrating the ICD and AIS. It can solve the issues of duplicate coding by addressing the differences in categorizations and coding principles in the two systems. However, the new classification should first be validated to ensure that ICD-10 coding and AIS 2008 coding produce the same results as the conversion from the bridging classification

before implementing actual integration into the ICD-11 as its clinical modification.

CONFLICT OF INTEREST

THE AUTHORS ARE members of the Japanese Association for Acute Medicine's Committee on ICD revision. No other conflict of interest was declared.

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