

Challenges of Integrating ICD 11 into Automatic Alerting Systems

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Abstract. Automatic alerting systems (AASs) can identify adverse health events but emergency communication relies on human operators and natural languages. For complete automation, we need to code the diversity of adverse events in a granularity that supports optimal dispatches. Hence, AAs shall integrate with the International Classification of Diseases (ICD). The ICD-11 coding system includes chapters for external causes of injury. However, ICD-11 supports coding injury incidents in electronic health records (EHRs) after they have occurred, while disregarding integrating real-time injury reporting within its framework. We explore the potential challenges associated with integrating ICD-11 into AAS by analyzing external causes of morbidity or mortality and the dimensions of external causes as potential areas of integration. We recognize the themes: (i) incident of injury, (ii) mode of transport, (iii) indoor location, (iv) outdoor location, and (v) type of building, and identify four challenges: (i) conceptual differences between the two systems, (ii) injury identification, (iii) presence of entities below the shoreline in ICD-11, and (iv) lack of specificity in certain ICD-11 codes related to AASs. For easy integration of ICD-11 into AASs, we recommend an AAS data dictionary and propose ICD-11 updates related to external causes of injury.

Keywords. Automatic alerting system, ICD-11, Challenges, Integration

1. Introduction

Automatic alerting systems (AASs) continuously monitor humans and their environment, capable of detecting adverse health events such as falls and traffic accidents. These systems are implemented in wearable technology [1], smart vehicles [2], and smart homes [3]. However, today's emergency calls still are based on natural language, where the answering dispatcher asks the caller questions [4]. Currently, no coding system supports a detailed description of the diverse emergencies that are required for an automatic dispatcher to react appropriately. The World Health Organization (WHO) has promoted the use of the International Classification of Diseases (ICD-11) to achieve semantic interoperability in digital health systems, including AASs [5]. The unified ICD-11 Application Programming Interface (API) is designed to seamlessly integrate with electronic health records (EHRs) and effectively address standardization challenges [6]. Integrating ICD-11 into AASs enhances standardization with EHRs and elevates the systems' ability to support a wide range of adverse events [7].

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The ICD-11 coding system includes Chapter 23, titled "External causes of morbidity or mortality", which contains codes used to identify the external causes of conditions classified as injury or poisoning [8]. More details can be found in the "Dimensions of external causes" extension codes category [9]. However, ICD-11 emphasizes the coding of injury incidents after the event has occurred, disregarding integration with AASs for real-time injury detection and alerting. Furthermore, the communication between alerting and responding systems is currently unsupported [10]. Therefore, we need further research to identify challenges associated with integrating ICD-11 into AASs.

2. Methods

AASs answer fundamental questions about the source of injury, including "Who?", "What?", "When?", "Where?", and "Why?" [4]. However, ICD-11 lacks the necessary details for full AAS implementation, while AASs struggle to identify injuries beyond alerting external causes. Therefore, it is necessary to pay attention to the common integration issues. The ICD-11 Chapter 23 and the extension codes present potential areas for integration into AASs. Hence, the main components suggested for integration are "What are the incidents of the injury", "What caused the injury?" and "Where did the incident occur?". As such, we qualitatively explore the potential challenges of integrating ICD-11 into AAS by identifying five themes and their respective categories (**Table 1**).

The "Incident of injury" is the first identified theme when exploring the challenges of integrating ICD-11 into AASs. These incidents, including transport accidents, falls, natural or technical disasters, and external violence, necessitate immediate alerting. The "Mode of transport", namely land, water, air, and space, is important when integrating ICD-11 into smart vehicle systems. The theme of ICD-11 that describes the place of events provides extension codes on "Aspects of the place of injury occurrence". We categorize three groups: "Outdoor location", "Indoor location", and "Type of building". These themes are essential for integrating ICD-11 into a smart home or smart vehicle systems that detect adverse events and generate automatic alerts.

Table 1. Themes and their categories for integrating ICD-11 into AAS

Themes	Categories	
Incident of injury	○ Transport accident	○ Technical disaster
	○ Fall	○ External violence
	○ Natural disaster	
Modes of transport	○ Land transport	○ Air transport
	○ Water transport	○ Space transport
Outdoor location	○ Residential area	○ Water area
	○ Mobility area	○ Underwater area
	○ Economical area	○ Airspace
	○ Landscape area	○ Deep space
	○ Underground area	
Indoor location	○ General living space	○ Industrial/craft space
	○ Sanitary space	○ Cultural space
	○ Sporting facility	○ Hazardous area
	○ Connecting space	○ Special room
	○ Gastronomic space	
Type of building	○ Private home	○ Industrial/construction building
	○ Residential Institution	○ Agricultural building
	○ Medical service area	○ Public/governmental building
	○ Educational building	○ Special building
	○ Sports and athletics building	

3. Results

In this study, we identified four main challenges in integrating ICD-11 into ASSs: conceptual difference, injury identification, presence of entities below the shoreline, and lack of specificity in certain ICD-11 codes.

3.1. Conceptual Differences

The stem codes in ICD-11 Chapter 23 lack certain automatic alerting concepts. In ICD-11, the grouping of external causes of injury is based on the intent of the injury, including unintentional, intentional, assault, or undetermined intent. On the other hand, AASs mainly focus on notifying the injury incidents rather than discerning the intent behind the harm. For example, these systems can capture per-injury concepts like "collision" and "entrapment" in a traffic accident. However, these concepts do not have specific stem codes in ICD-11. While these concepts are included in ICD-11 with various index terms based on vehicle types, it may still be necessary to translate them into ICD-11 stem codes that closely align with AAS. The conceptual difference also poses challenges for post-coordination in AASs due to their automatic alert generation without manual coding of ICD-11 entities. Hence, we need to design and implement AAS that are capable of post-coordination of ICD codes based on the incidents that have occurred.

3.2. Injury Identification

AASs can improve healthcare by alerting incidents of injury beyond continuous parameter monitoring (Figure 1). Two critical steps facilitate this process: (i) incident detection by sensor-based continuous health monitoring embedded into smart homes, smart vehicles, and smart wearables; and (ii) alerting of incidents, and adverse health events. For example, the health monitoring detects acute irregularities of vital signs, or the smart ladder detects a fall from rung six, which equals a drop of 1,4 m (4,6 feet). Integrating ICD-11 coding allows for prompting the correct alert, taking into account incidents of injury, mode of transport, and place of occurrence. On the other hand, accurately identifying injuries is challenging for AASs. Hence, interoperability with EHRs is critical. The details of injury incidents should be fed into EHRs to assist physicians in accurate injury identification and complete coding of the injury.

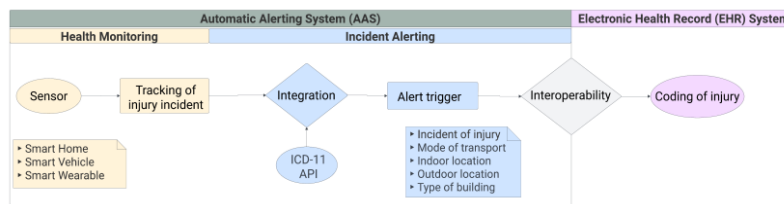


Figure 1. Phases of Injury Identification

3.3. Entities Below the Shoreline

ICD-11 includes "entities below the shoreline" as index terms without rubric codes. These entities are indexed and represented by the codes of their parent categories in the ICD-11 Mortality and Morbidity Statistics (MMS) linearization. They are also linked via

a Uniform Resource Identifier (URI) to the WHO Family of International Classifications (WHO-FIC) foundation. One instance where indexed entities are noticeable is when coding collisions. The ICD-11 MMS linearization indexes traffic accidents involving collisions between vehicles and/or pedestrians within each category of unintentional transport injury events. However, there is no specific ICD-11 code designated for collisions between vehicles and/or humans in ICD-11 MMS; instead, they are classified under the parent category ICD-11 codes. **Figure 2** illustrates an example of "entities below the shoreline" in the ICD-11 MMS linearization [11]. These entities indexed under PA04 "Unintentional land transport traffic event injuring a car occupant", are indicated by the small blue triangles, when clicked, display their unique foundation URIs.

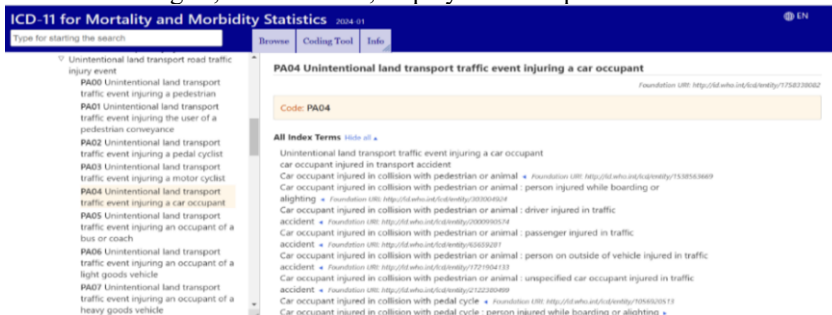


Figure 2. Examples of "entities below the shoreline" in ICD-11

3.4. Lack of Specificity

The ICD-11 extension codes do not provide entities needed to represent specific details related to AASs. For instance, it may be necessary to introduce new concepts such as "rescue vehicle" and "e-vehicle" when integrating ICD-11 into AASs. Ambulances, fire trucks, and police cars serve as examples of rescue vehicles. Similarly, the e-vehicle should encompass vehicles such as electric cars, pedelecs, e-scooters, e-bikes, personal transporters (known as Segway), e-kickboards, and monowheels. However, these innovative technologies and their AAS concepts mismatch specific ICD-11 coding.

4. Discussion

In this study, we examined "External causes of mortality or morbidity" and the "Dimensions of external causes" as potential areas for integrating ICD-11 into AASs. Based on these existing ICD-11 components, we propose five themes to explore challenges. In ICD-11, concepts related to AAS are listed based on the intent of the injury. This leads to conceptual differences, with concepts related to AASs having multiple ICD-11 code options depending on various details, without specific parent groupings. Hence, providing a cohesive framework within the ICD-11 classification system might be necessary by assigning stem codes to categorize concepts related to AASs.

Accurate identification of injury details is another challenge. Smooth integration with EHRs is essential for injury identification [12]. This presents a unique opportunity to collect external causes of injury from populations at risk, aiding clinical decisions and early prevention. ICD-11 is not only used for statistical purposes; it's endorsed by the WHO as one way to achieve semantic interoperability in digital health systems, including

AAs [5]. However, integrating ICD-11 into AASs remains a challenge, even though linking EHRs to ICD-11 has already been accomplished [13]. This is because the ICD-11 framework is more aligned with EHRs, yet currently, nothing is done to adequately support AASs. Another challenge arises, as some concepts for automatic alerting are masked and represented by unrelated parent categories. Furthermore, we found that ICD-11 insufficiently provides specific details for recent technologies and other entities relevant to external causes of injury. As technology advances, some rescue or e-vehicles can come equipped with built-in alerting systems. In these cases, the best way to integrate ICD-11 into AASs is to include these innovative technologies.

5. Conclusions

To date, ICD-11 MMS linearization does not sufficiently support automatic communication in the early rescue chain, for instance, concerning AAS. Incidents of injury, mode of transport, indoor location, outdoor location, and type of building are the main themes to address. The challenges include conceptual disparities between AAS and ICD-11, difficulties in identifying injuries, entities below the shoreline, and the lack of specificities of certain ICD-11 codes. An alerting dictionary in combination with further updates in ICD-11 and its extension codes is required.

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