

# Adaptation of AHRQ Patient Safety Indicators for Use in ICD-10 Administrative Data by an International Consortium

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## Abstract

**Objective:** The Agency for Healthcare Research and Quality (AHRQ) developed Patient Safety Indicators (PSIs) for use with ICD-9-CM data. Many countries have adopted ICD-10 for coding hospital diagnoses. We conducted this study to develop an internationally harmonized ICD-10 coding algorithm for the AHRQ PSIs. **Methods:** The AHRQ PSI Version 2.1 has been translated into ICD-10-AM (Australian Modification), and PSI Version 3.0a has been independently translated into ICD-10-GM (German Modification). We converted these two country-specific coding algorithms into ICD-10-WHO (World Health Organization version) and combined them to form one master list. Members of an international expert panel—including physicians, professional medical coders, disease classification specialists, health services researchers, epidemiologists, and users of the PSI—independently evaluated this master list and rated each code as either “include,” “exclude,” or “uncertain,” following the AHRQ PSI definitions. After summarizing the independent rating results, we held a face-to-face meeting to discuss codes for which there was no unanimous consensus and newly proposed codes. A modified Delphi method was employed to generate a final ICD-10 WHO coding list. **Results:** Of 20 PSIs, 15 that were based mainly on diagnosis codes were selected for translation. At the meeting, panelists discussed 794 codes for which consensus had not been achieved and 2,541 additional codes that were proposed by individual panelists for consideration prior to the meeting. Three documents were generated: a PSI ICD-10-WHO version-coding list, a list of issues for consideration on certain AHRQ PSIs and ICD-9-CM codes, and a recommendation to WHO to improve specification of some disease classifications. **Conclusion:** An ICD-10-WHO PSI coding list has been developed and structured in a manner similar to the AHRQ manual. Although face validity of the list has been ensured through a rigorous expert panel assessment, its true validity and applicability should be assessed internationally.

## Introduction

Patient safety is a critical component of health care quality that has been widely studied.<sup>1, 2, 3, 4, 5</sup> Assessments of patient safety are traditionally done through chart reviews, surveys, and voluntary hospital reporting of adverse events and medical errors. These data collection methods focus on specific types of events, often collect data that may not be generalizable to any population of interest, cover limited geographic areas, and may be too labor-intensive for widespread use. Therefore, researchers have become interested in using routinely collected administrative data for population-based studies of adverse events.

In response, the Agency for Healthcare Research and Quality (AHRQ) and the University of California-Stanford Evidence-based Practice Center developed patient safety indicators (PSIs) for use with hospital administrative data coded using the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM), which are readily available and relatively inexpensive to use.<sup>6</sup> The AHRQ PSIs were developed through a literature search, review of ICD-9-CM manuals, consultation with physician panels, and empirical data analyses. Over 200 ICD-9-CM codes representing potential patient safety problems were identified, and 48 indicators were labeled as the most promising PSIs by the AHRQ research team. Of these, 20 hospital-level and seven area-level PSIs were recommended by one or more multispecialty panels as a set of “accepted” indicators.<sup>6</sup> The first set of AHRQ PSIs was released in 2003 and has been updated periodically since then.

The 20 hospital-level indicators are used to identify potential inpatient complications that might represent events related to patient safety. The seven area-level indicators are designed to detect patient safety events on a regional level such as “Foreign body left during procedure.” Although the seven area-level indicators are closely related to the 20 hospital-level measures, the method of defining these seven area-level indicators is different. Area level indicators are designed to estimate the prevalence of each PSI in a jurisdiction or region. Therefore, the denominator includes the entire eligible population of a region, rather than just cases treated in a particular hospital. The numerator is based on both principal and secondary diagnoses, whereas for hospital-level indicators, the numerator is based only on secondary diagnoses.<sup>6</sup> Inclusion of principal diagnoses in the area-level numerators captures patients who were admitted due to complications that occurred in previous hospitalizations or outpatient care episodes.

To facilitate utilization of the PSIs, AHRQ developed and distributes (at no cost) SAS<sup>®</sup> and Windows<sup>®</sup>-based software tools. These tools can be used to help hospitals identify potential adverse events that might need further study and also to enable users to assess the occurrence of in-hospital adverse events using routinely collected ICD-9-CM hospital discharge abstract data.

The PSI tools for ICD-9-CM cannot be applied to ICD-10<sup>7</sup> data because ICD-10 uses an alphanumeric system, and many codes are not directly convertible. The ICD-10 classification has been developed and is maintained by the World Health Organization (WHO). Updates to the ICD-10 are based on recommendations of the Update and Revision Committee that meets annually to discuss and ratify proposals. Major updates (e.g., new codes) are implemented every 3 years, while minor updates (e.g., corrections) are implemented annually. Implementation of ICD-10 began in 1994, but it has not yet been adopted for morbidity coding in the United States. The major differences between the ICD-10 and ICD-9-CM coding systems are:

- The tabular list of diseases in ICD-10 has 22 chapters, compared to 19 chapters in ICD-9-CM. The chapter on diseases of the nervous system and sense organs in ICD-9-CM is expanded to three chapters in ICD-10, including diseases of the nervous system, diseases of the eye and adnexa, and diseases of the ear and mastoid process. ICD-10 specifies certain conditions in more detail than ICD-9-CM by adding anatomical sites and type of injury (open or closed).
- The codes in ICD-10 are alphanumeric, whereas codes in ICD-9-CM are numeric. Each code in ICD-10 starts with a letter (i.e., A - Z), followed by two numeric digits, a decimal point, and a digit (e.g., acute bronchiolitis due to respiratory syncytial virus is J21.0). In contrast, codes in ICD-9-CM begin with three-digit numbers (i.e., 001 - 999) followed by a decimal and up to two digits (e.g., acute bronchiolitis due to respiratory syncytial virus is 466.11).

Canada, Australia, New Zealand, and many European and Asian countries have used the ICD-10 to code hospital discharge diagnoses since the system was introduced, but the development of quality indicators based on ICD-10-coded data has lagged behind. Starting in 2004, the Canadian Institute for Health Information began evaluating the AHRQ PSIs and selected a subset for public reporting on health system performance.<sup>8</sup> Concurrently, Drösler and colleagues in Germany mapped the AHRQ PSIs from ICD-9-CM to ICD-10 and licensed this mapping to the German subsidiary of 3M, so that German hospitals could monitor their rates of potential safety-related events.<sup>9</sup> Demand from potential users of the AHRQ PSIs in these and other countries prompted us to conduct this study to develop an internationally harmonized ICD-10 coding algorithm for the PSIs.

This study was spearheaded by the International Methodology Consortium for Coded Health Information (IMECCHI), an international group of experts dedicated to the development and validation of health research methodologies for coded health data.<sup>10</sup> At its meeting in 2005, IMECCHI members identified the development of ICD-10 WHO coding algorithms for PSIs as a high priority initiative. Coincidentally, the Organization for Economic Cooperation and Development (OECD) launched its Health Care Quality Indicator (HCQI) Project in 2001, and identified five priority areas for initial development of indicators that could be used to explore quality differences across 23 participating countries: (1) cardiac care, (2) diabetes mellitus, (3) mental health, (4) patient safety, and (5) prevention/health promotion combined with primary care.

To identify and evaluate potential indicators of patient safety, the OECD convened a Patient Safety Panel, which then solicited indicators covering “five core domains of patient safety”: (1) hospital-acquired infections, (2) sentinel events, (3) operative and postoperative complications, (4) obstetrics, and (5) other care-related adverse events. Fifty-nine indicators from seven different sources were evaluated through a nominal group process; the Panel agreed on a final list of 21 indicators (including 12 AHRQ PSIs) that were deemed suitable, based on both importance and scientific soundness.<sup>11</sup> In followup, the OECD convened health ministerial representatives from its member countries and experts to collaborate around patient safety data systems on June 29 and 30, 2006, in Dublin, Ireland.<sup>12</sup> At the meeting, international harmonization of ICD-10 PSI definitions was identified as an urgent task, and the OECD Secretariat agreed to facilitate this undertaking.

## Methods

### Selection of PSIs for Translation

Defining PSI events (numerators) requires searching diagnosis and procedure code fields in hospital discharge abstract data, but defining denominators often requires the use of diagnosis-related groups (DRGs) to identify eligible hospitalizations. For example, the events coded as “foreign body left during procedure” (PSI 5) are found by searching for the ICD-9-CM codes 998.4 and 998.7 in secondary diagnosis fields. The denominator for this indicator includes all surgical and medical discharges, which are determined by specific surgical and medical DRGs.

To develop ICD-10-WHO (World Health Organization version) definitions for each PSI, we therefore needed to consider the following realities:

**Reality 1.** Various country-specific ICD-10 versions are available. Canada, Australia, Germany, and other countries have enhanced ICD-10 by adding more specific codes and released country-specific versions, such as ICD-10-CA (Canadian modification<sup>13</sup>), ICD-10-AM (Australian modification<sup>14</sup>) and ICD-10-GM (German modification<sup>15</sup>). The National Center for Health Statistics has developed ICD-10-CM for eventual use in the United States, but these codes “are not currently valid for any purpose or use.”<sup>16</sup> The basic ICD-10-WHO structure, scope, and code definitions are not altered in these country-specific modifications, which mainly extend code character levels, from the third and fourth levels of ICD-10 to fourth-, fifth-, or sixth-character levels (e.g., “O10.0 pre-existing essential hypertension complicating pregnancy, childbirth, and the puerperium” in ICD-10-WHO subsumes “O10.001 pre-existing essential hypertension complicating pregnancy, childbirth, and the puerperium - delivered, with or without mention of antepartum condition” in ICD-10-CA). ICD-10 country-specific modifications also include a few additional third- and fourth-level codes, consistent with the existing classification structure. Some countries do not adopt all codes from the chapter “External causes of morbidity and mortality” (e.g., 22 codes in ICD-10-GM vs. 1,366 codes in ICD-10-WHO).

**Reality 2.** Each country uses its own distinct procedure coding system, limiting data comparability because ICD-10-WHO classifies medical conditions only, not procedures. For example, Switzerland uses a procedure coding system derived directly from ICD-9-CM.<sup>17</sup> Canada developed its own procedure classification (the Canadian Classification of Health Interventions [CCI]<sup>13</sup>). Australia developed the Australian Classification of Health Interventions (ACHI),<sup>18</sup> and Germany developed the German procedure classification (OPS).<sup>19</sup>

**Reality 3.** Various patient classification systems have been utilized across countries. Australia has developed ICD-10 DRGs based on ICD-10-AM; Germany has introduced the G-DRG system based on ICD-10-GM. The Canadian Institute for Health Information (CIHI) developed ICD-10-CA/CCI case-mix groups (CMG +) to predict resource utilization; this new methodology was implemented on April 1, 2007.<sup>20</sup> Switzerland currently uses All Patient-Diagnosis Related Groups (AP-DRGs) but will adopt the German DRG system soon.

Considering these three realities, we focused on developing ICD-10-WHO coding algorithms for PSIs that mainly rely on diagnosis codes for defining PSI inclusion and exclusion criteria. We finally selected 15 PSIs (Table 1). However, country-specific procedure codes are required for

adapting the coding algorithms to define some of these PSIs, such as “Postoperative physiologic and metabolic derangement.”

## **Process of Translation**

The following three major steps were taken to develop ICD-10 coding algorithms.

### **Step 1: Searching ICD-10 Diagnosis Codes**

The original ICD-9-CM codes embedded in the AHRQ PSIs were converted to ICD-10 codes using currently available Australian and German ICD-9 and ICD-10 crosstable mapping algorithms. Our Australian investigators used a conversion table between ICD-9-CM and ICD-10-AM, while our German investigator used a conversion table to ICD-10-GM and manually reviewed the results for each code.<sup>21, 22</sup> All ICD-10 codes identified in both translations were combined additively to generate a diagnosis code master list. All country-specific codes that extended original ICD-10-WHO codes were truncated, and country-specific additional codes were excluded to maintain ICD-10-WHO formatting. All codes were described using their titles as listed in the ICD-10-WHO manual.

### **Step 2: Panel Review and Assessment**

Twenty-one members of the PSI working group—including physicians, health services researchers—and coding professionals, independently (or as a geographic research team) reviewed the comprehensive code list. Each reviewer compared ICD-10-WHO codes with AHRQ’s ICD-9-CM codes, using the AHRQ PSI Technical Manual (Version 3.0a)<sup>6</sup> to clarify AHRQ’s intent with respect to each code. The reviewers were asked to rate each diagnosis code as “Include,” “Exclude,” or “Uncertain.” For those who reviewed as a team, a final rating was made after internal discussions.

The German results have been tested on large national databases; substantial concordance was shown between German PSI rates calculated in ICD-10 and the U.S. rates published by AHRQ.<sup>23</sup> However, we could not be certain that the coding list generated using Australian and German conversion tables would capture every relevant ICD-10-WHO code. Therefore, we asked reviewers to propose diagnosis codes that might have been omitted from the master list of codes.

### **Step 3: Face-to-Face Meeting**

The purpose of the face-to-face meeting was to discuss codes for which consensus was not reached at the second step. Because of inconsistencies in coding practices across countries and code descriptions between ICD-9-CM and ICD-10, the following guidelines were established before voting:

**Rule 1.** Codes were selected for detailed discussion when consensus was not reached due to differences in country-specific coding standards. If coders in one country were advised to use code A for a specific condition, but in another country they were advised to use code B for the same condition, then both codes A and B were retained.

**Table 1. Selected PSIs and denominator definitions**  
 (Adopted from AHRQ Technical Specifications, Version 3.0a, May 1, 2006.  
 See AHRQ manual for further exclusions.)

<b>PSI title</b>	<b>Selected PSI for ICD-10-WHO translation</b>	<b>Denominator population</b>	<b>Major diagnosis category (MDC) exclusion</b>	<b>Procedure codes requirement</b>
<b>PSI 1: Complications of anesthesia</b>	Yes	All surgical discharges age ≥18 years or MDC 14 (pregnancy, childbirth, and puerperium)	No	No
<b>PSI 2: Death in low-mortality</b>	No, because it heavily relies on DRG			
<b>PSI 3: Decubitus ulcer</b>	Yes	All medical and surgical discharges age ≥18 years, length of stay >4 days	MDC 9 (skin, subcutaneous tissue, and breast); MDC 14 (pregnancy, childbirth, and puerperium)	Yes, debridement or pedicle graft
<b>PSI 4: Failure to rescue</b>	No, because many procedure codes are required			
<b>PSI 5: Foreign body left during procedure</b>	Yes	All surgical and medical discharges age ≥18 years or MDC 14 (pregnancy, childbirth, and puerperium)	No	No
<b>PSI 6: Iatrogenic pneumothorax</b>	Yes	All surgical and medical discharges age ≥18 years		Yes, diaphragmatic surgery repair, thoracic surgery, lung or pleural biopsy, or cardiac surgery
<b>PSI 7: Selected infections due to medical care</b>	Yes	All surgical and medical discharges age ≥18 years	No	No

**Table 1. Selected PSIs and denominator definitions (continued)**  
 (Adopted from AHRQ Technical Specifications, Version 3.0a, May 1, 2006.  
 See AHRQ manual for further exclusions.)

PSI title	Selected PSI for ICD-10-WHO translation	Denominator population	Major diagnosis category (MDC) exclusion	Procedure codes requirement
<b>PSI 8: Postoperative hip fracture</b>	Yes	All surgical discharges age ≥18 years	MDC 8 (diseases and disorders of the musculoskeletal system and connective tissue); MDC14 (pregnancy, childbirth, and puerperium)	Yes, hip fracture repair
<b>PSI 9: Postoperative hemorrhage or hematoma</b>	No, because many procedure codes are required			
<b>PSI 10: Postoperative physiologic and metabolic derangement</b>	Yes	All surgical discharges age ≥18	MDC 14 (pregnancy, childbirth, and puerperium)	Yes, dialysis
<b>PSI 11: Postoperative respiratory failure</b>	No, because many procedure codes are required			
<b>PSI 12: Postoperative pulmonary embolism or deep vein thrombosis</b>	Yes	All surgical discharges age ≥18	MDC 14 (pregnancy, childbirth, and puerperium)	Yes, interruption of vena cava
<b>PSI 13: Postoperative sepsis</b>	Yes	All elective (defined by the admission type) surgical discharges age ≥18 years and length of stay >3 days	MDC 14 (pregnancy, childbirth, and puerperium)	No























