
A review of the Classification of Hospital-Acquired Diagnoses (CHADx)

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Published by the State of Queensland (Queensland Health), October, 2012



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A review of the Classification of Hospital-Acquired Diagnoses (CHADx)

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Key findings

- The CHADx offers a comprehensive classification of hospital-acquired conditions available for use with ICD-10-AM.
- The CHADx was developed as a tool for use within hospitals, allowing hospitals to monitor (assuming constant casemix) and reduce hospital-acquired illness and injury.
- Within Queensland in 2010/2011, 9.0% of all admissions included at least one hospital-acquired condition (as defined by the CHADx).

1.0 Background and purpose of the report

Illness and injury incurred in hospital are costly to both health providers and patients, increasing the costs of hospital care by an estimated 17.3%.¹ Data on patient safety is therefore essential to enable hospitals to monitor and reduce hospital-acquired illness and injury. There is limited information available to hospitals on such matters.

The Classification of Hospital-acquired Diagnoses (CHADx) was developed by researchers at the Australian Centre for Economic Research on Health, with funding provided by the Australian Commission on Safety and Quality in Health Care. The purpose of the CHADx, as envisioned by its' developers, was "to allow Australian hospitals to monitor the range of hospital-acquired diagnoses coded in routine data in support of quality improvement efforts"². Essentially, the CHADx was developed so that hospitals would be able to track unintentional patient harm. As such, it was intended for use within hospitals, and not intended as a means for external monitoring of hospital activity and holding hospitals to account.

The CHADx requires the collection of a *Condition Present on Admission* (CPoA) variable, which indicates whether a condition was 'present on admission' or 'not present on admission'. If a condition was not 'present on admission', it is deemed to have been acquired in hospital (i.e. hospital-acquired). The CPoA variable began collection nationally in Australia on 1 July 2008, although it was already being collected in some jurisdictions prior to this. In Queensland, the variable was collected from 1 July 2006³. In addition to the CPoA variable, the CHADx utilises an extensive range of definitions⁴ based on ICD-10-AM in order to identify hospital-acquired diagnoses and also arrange them into clinically meaningful classes.

Initially, the CHADx was developed for use with 5th edition ICD-10-AM (implemented July 2006), however it has undergone several revisions. Recently, in 2010/2011, the Australian Commission on Safety and Quality in Health Care mapped the classification to 7th edition ICD-10-AM, while also reviewing and refining the definitions that allocate diagnoses to a CHADx class⁵. In July 2011, the Commission released CHADx version 4.1, which includes over 4,500 valid hospital-acquired diagnosis codes classified into 145 sub-classes, which in turn comprise 17 major classes:

1. Post-Procedural Complications
2. Adverse Drug Events
3. Accidental Injuries
4. Specific Infections
5. Cardiovascular Complications
6. Respiratory Complications
7. Gastrointestinal Complications
8. Skin Conditions
9. Genitourinary Complications
10. Hospital-Acquired Psychiatric States
11. Early Pregnancy Complications
12. Labour, Delivery and Postpartum Complications
13. Perinatal Complications
14. Haematological Complications
15. Metabolic Disorders
16. Nervous System Complications
17. Other Complications

This technical report aims to identify the strengths and weaknesses inherent with the CHADx, while also assessing its potential usefulness within Queensland Health. Review of the clinical validity of the CHADx is beyond the scope of this report.

2.0 Applying CHADx to the QHAPDC Data

Sections 2.1 and 2.2 briefly investigate the percentage of episodes with hospital-acquired diagnoses across Queensland public hospitals, using the definitions of the CHADx.

2.1 Method

The Queensland Hospital Admitted Patient Data Collection (QHAPDC) contains diagnosis information for each admitted patient episode, including principal diagnosis, other diagnoses, morphology codes and external causes. Diagnosis codes are sourced from the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM). In addition, each diagnosis is assigned a *Condition Present on Admission* value from 1 July 2006, with the exception of morphology codes, where the CPoA variable was recorded from 1 July 2008. However, morphology codes do not appear in the CHADx since they cannot be reasonably hospital-acquired. As a result, the CHADx definitions can be applied to the QHAPDC data from 1 July 2006.

All relevant diagnoses (including principal diagnosis, other diagnoses and external causes) were extracted from the QHAPDC for the 2006/2007–2010/2011 financial years, including only public facilities and excluding boarders, organ procurement and unqualified neonates. The CHADx definitions* (version 4.1[†]) were then applied to the data[‡], grouping all diagnoses into relevant CHADx classes.

* The CHADx definitions were adjusted to reflect the ICD-10-AM codes from relevant years, i.e. 5th edition ICD-10-AM codes were applied for 2006/2007–2007/2008, 6th edition ICD-10-AM codes were applied for 2008/2009–2009/2010, and 7th edition ICD-10-AM codes were applied for 2010/2011.

† A more recent version (i.e. version 4.2) of the CHADx was released in August 2012. However, the few changes from version 4.1 are minor.

2.2 Results

Figure 2-1 presents the percentage of episodes from 2006/2007 to 2010/2011 that contained one or more hospital-acquired diagnoses from any CHADx class. The overall percentage increases each year from 7.4% in 2006/2007 to 9.0% in 2010/2011.

Figure 2-1 Percentage of episodes with one or more hospital-acquired diagnoses by year, 2006/2007-2010/2011.

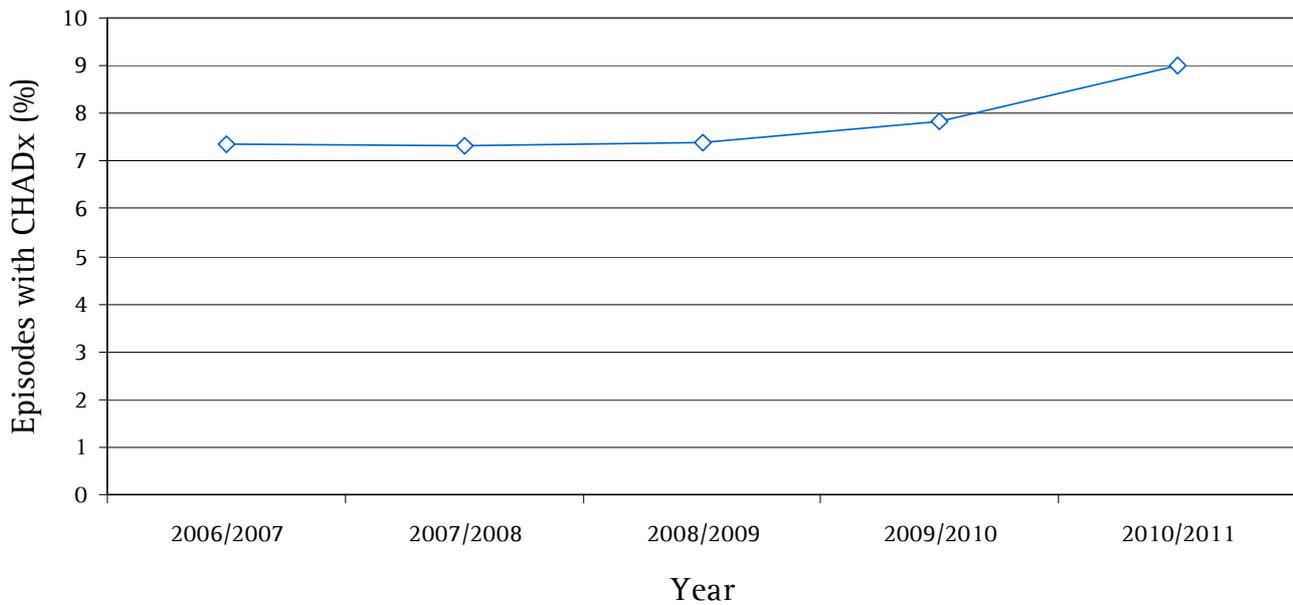
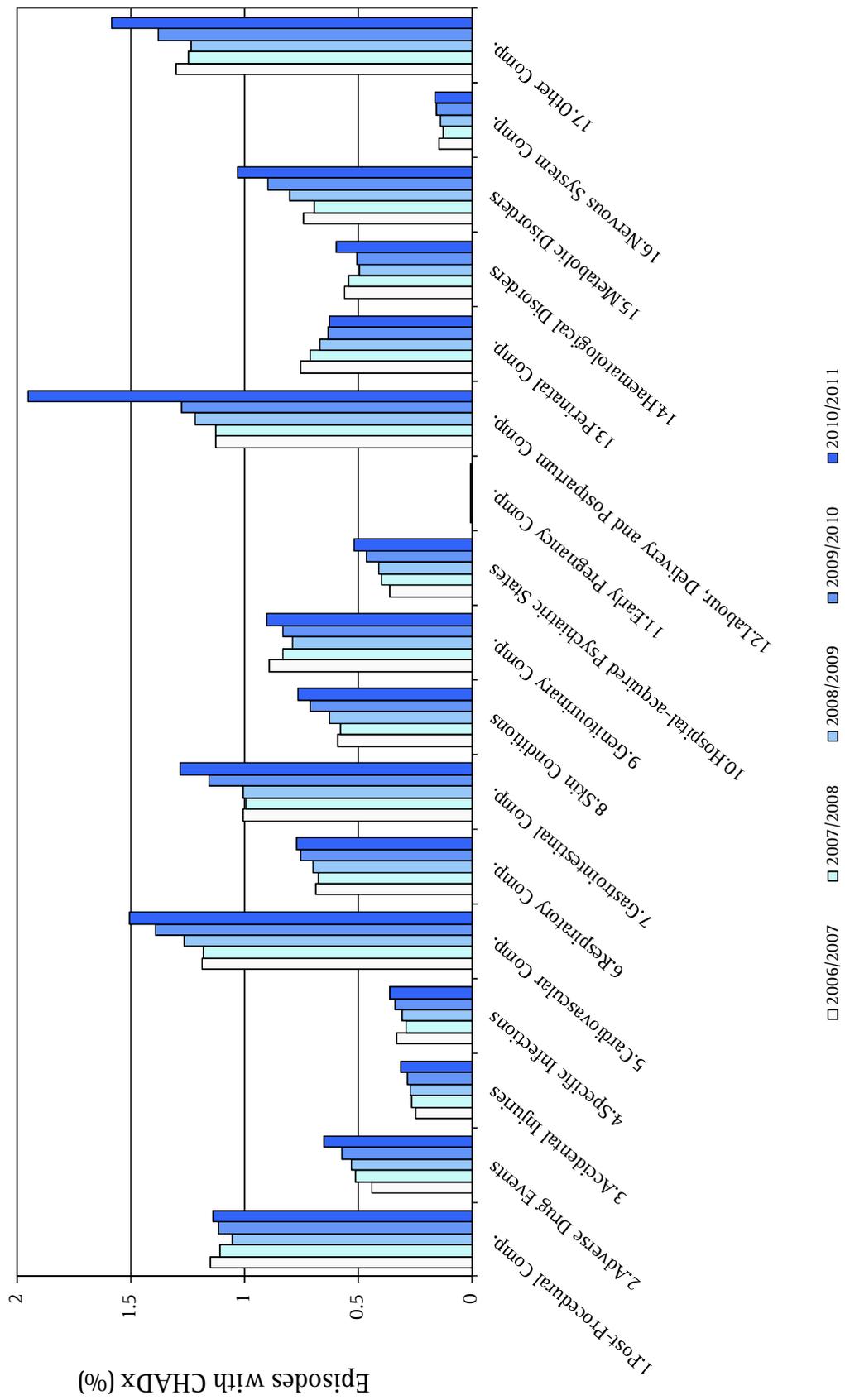


Figure 2-2 presents the percentage of episodes that contained one or more hospital-acquired diagnoses, broken down by CHADx class and year. Where an episode contained diagnoses from several CHADx classes, it was counted once in each relevant class i.e. a single episode can be counted in multiple classes. Over the 5 years, classes 17 (other complications), 5 (cardiovascular complications), 12 (labour, delivery and postpartum complications) and 1 (post-procedural complications) registered the highest percentage of episodes while classes 11 (early pregnancy complications), 16 (nervous system complications), 4 (specific infections) and 3 (accidental injuries) registered the lowest. These results are consistent with a previous analysis² that applied the CHADx definitions to Victorian data for the 2005/2006 financial year. That report tabulated the frequency of hospital-acquired diagnoses by CHADx class, with diagnoses from classes 12, 13, 5 and 17 appearing most frequently and diagnoses from classes 16, 11, 4 and 3 appearing least frequently. Figure 2-2 also indicates that the percentage of episodes with a hospital-acquired diagnosis has increased overall from 2006/2007 to 2010/2011 for most CHADx classes, with the only exceptions being classes 1 (post-procedural complications) and 13 (perinatal complications). Most notably, class 12 (labour, delivery and postpartum complications) experienced a sharp increase from 2009/2010 to 2010/2011. The cause of this increase is explored in Section 3.3 of this report.

[#] Several definitions from the classification required some degree of interpretation in order to be applied to the QHAPDC data. Additionally, some adjustments were made where improvement to the CHADx definitions was foreseeable. All such interpretations and adjustments are listed in the appendix (section 9.0) of this document.

Figure 2-2 Percentage of episodes with a hospital-acquired diagnosis by CHADx class and year, 2006/2007-2010/2011.



Note: A single episode can be counted in multiple classes if it includes conditions from multiple classes.

3.0 CHADx coding issues

A number of known coding issues in the QHAPDC have a direct impact on the reliability of several classes/sub-classes of the CHADx classification. These issues are highlighted in sections 3.1 to 3.4.

3.1 Condition Present on Admission Variable

Because the CHADx relies upon a *Condition Present on Admission* (CPoA) variable to identify hospital-acquired diagnoses, its validity is dependent on the quality of the variable. A previous Queensland Health technical report, which assessed the quality of the CPoA variable in the QHAPDC, used a subset of CHADx sub-classes to identify the error rate of expected hospital-acquired diagnoses⁶. The report identified sixteen diagnosis codes from seven CHADx sub-classes (Table 3.1) where, with the exception of transferred patients, the CPoA variable was expected to have been recorded as 'hospital-acquired'.

Table 3.1 CHADx sub-classes where the included diagnoses are expected to have been assigned a *Condition Present on Admission* value of hospital-acquired.

| CHADx Sub-class | | ICD-10-AM codes | |
|-----------------|---|-----------------|---|
| 1.3 | Failed or difficult intubation | T88.4 | Failed or difficult intubation |
| 1.5 | Accidental puncture/laceration during procedure | T81.2 | Accidental puncture/laceration during procedure |
| 12.1 | Foetal heart anomalies | 068.0 | Labour and delivery complicated by fetal heart rate anomaly |
| | | 068.2 | Labour and delivery complicated by fetal heart rate anomaly with meconium in amniotic fluid |
| 12.4 | Unsuccessful interventions during labour | 061.0 | Failed medical induction of labour |
| | | 061.1 | Failed instrumental induction of labour |
| | | 061.8 | Other failed induction of labour |
| | | 061.9 | Failed induction of labour, unspecified |
| | | 066.5 | Failed application of vacuum extractor and forceps, unspecified |
| | | 075.5 | Delayed delivery after artificial rupture of membranes |
| 12.6 | First degree and unspecified perineal tear | 070.0 | First degree perineal laceration during delivery |
| | | 070.9 | Perineal laceration during delivery, unspecified |
| 12.7 | Second degree perineal tear | 070.1 | Second degree perineal laceration during delivery |
| 12.8 | Third degree and fourth degree perineal tear | 070.2 | Third degree perineal laceration during delivery |
| | | 070.3 | Fourth degree perineal laceration during delivery |

For all Queensland hospitals (including public and private), the report found that 26.6% of the expected hospital-acquired diagnoses had a CPoA value of *present on admission* in 2009/2010 i.e. a potential error rate of 26.6%. Of the listed classes, 1.3 (failed or difficult intubation) had the highest error rate of 31.1%, while 1.5 (accidental puncture/laceration during procedure) had the lowest of 19.5%. Consequently, there is some concern over the accuracy with which the CPoA variable has been assigned in Queensland hospitals. Specifically, the sub-classes identified in Table 3.1 are likely to have been

under-represented, in many cases by a potential 30%.⁶ For the CHADx sub-classes that are not contained in Table 3.1, the accuracy of the CPoA variable cannot be determined. However, since the listed diagnoses have been under-represented due to the mis-assignment of the CPoA variable, it is possible that other hospital-acquired conditions have also been under-represented for the same reason.

3.2 Pressure Ulcers

The definition of sub-class 8.1 (pressure ulcers) of the CHADx includes ICD-10-AM diagnosis code L89.x (decubitus ulcer and pressure area). Table 3.2 lists the various stages of pressure ulcers that comprise ICD-10-AM code L89.x.

Table 3.2 L89.x (decubitus ulcer and pressure area) ICD-10-AM codes and descriptions.

| ICD-10-AM code | Description |
|----------------|--|
| L89.0 | Stage I decubitus ulcer and pressure area |
| L89.1 | Stage II decubitus ulcer and pressure area |
| L89.2 | Stage III decubitus ulcer and pressure area |
| L89.3 | Stage IV decubitus ulcer and pressure area |
| L89.9 | Decubitus ulcer and pressure area, unspecified |

The Australian Coding Standard (ACS) 1221 (sixth and seventh edition) describes the coding guidelines for *decubitus ulcer and pressure area* and indicates that patients who have multiple ulcer sites of differing stages should only be assigned one code to indicate the highest stage^{7, 8}. This instruction would result in an under-representation of L89 diagnoses for patients with multiple pressure ulcers.

In addition, there is confusion regarding the coding of pressure ulcers for patients with diabetes. The ACS 0401 (seventh edition, example 14) describes a scenario where a patient with type 2 diabetes is admitted for treatment of a left foot ulcer. The patient is diagnosed with E11.73 (*Type 2 diabetes mellitus with foot ulcer due to multiple causes*), however a separate code for the foot ulcer is not assigned as ACS 0401 states:

Multiple coding (see ACS 0027) should not be used when the classification provides a combination code (see ACS 0015) for the diabetes that clearly identifies all of the elements documented in the diagnosis.⁸

In the above scenario, as both conditions (diabetes and the foot ulcer) are described in the code title, a separate code to identify the foot ulcer is not required. This conflicts with coding advice that was earlier issued by the National Centre for Classification in Health (NCCCH), which indicated that in cases where the foot ulcer could be classified as L89.2 or L89.3, these codes should be assigned *in addition* to the diabetes diagnosis⁹. As a result, it is not entirely clear to coders whether the pressure ulcer should be assigned or not, again resulting in a potential under-representation of L89 diagnoses. These issues, when taken together, indicate that CHADx sub-class 8.1 is likely to be under-represented.

3.3 Changes in Coding of Obstetric Codes

Figure 2-2 (see Section 2.2) indicated a large increase in CHADx class 12 (*pregnancy, childbirth and the puerpium*) from 2009/2010 to 2010/2011. Table 3.3 displays the number of diagnosis codes from CHADx class 12 broken down by ICD type (*other diagnoses* or *principal diagnosis*). In Table 3.3 all ICD

types and *Condition Present on Admission* values have been included, whereas the CHADx definitions only include diagnoses with an ICD type of *other diagnoses* and a CPoA value of *hospital-acquired*. Table 3.3 indicates that overall, the total number of class 12 diagnosis codes is reasonably constant, although it steadily increases each year. However, in 2010/2011, the percentage of diagnoses assigned as *principal diagnosis* decreases from 47.2% to 15.2%, while the percentage of diagnoses assigned as *other diagnoses* increases from 52.8% to 84.8%. This is the result of a change in the 7th edition Australian Coding Standards. The ACS 0001 (seventh edition), which describes the coding of principal diagnosis, offers the following instruction for obstetric codes:

*Where the patient is admitted for delivery such as ‘in labour’, ‘for induction’, ‘for caesarean’, and the outcome is delivery, assign a code from category O80–O84 Delivery as the principal diagnosis, followed by the reason for any intervention and then any other conditions and/or complications that meet the criteria for assignment as per ACS 0002 Additional diagnoses.*⁸

This instruction was not present in previous editions of the Australian Coding Standards so that obstetric codes outside the range of O80–O84 were assigned as *principal diagnosis*. With the addition of the obstetric coding guidelines to ACS 0001, these obstetric codes that were previously being assigned as *principal diagnosis* were assigned in 2010/2011 as *other diagnoses*.

Table 3.3 Diagnosis codes from CHADx class 12 by ICD type year.

| Year | Other Diagnoses | | Principal Diagnosis | | All ICD Types | |
|-----------|-----------------|------|---------------------|------|---------------|-------|
| | N | % | N | % | N | % |
| 2006/2007 | 19,761 | 45.7 | 23,482 | 54.3 | 43,243 | 100.0 |
| 2007/2008 | 21,214 | 46.9 | 24,057 | 53.1 | 45,271 | 100.0 |
| 2008/2009 | 24,144 | 50.8 | 23,424 | 49.2 | 47,568 | 100.0 |
| 2009/2010 | 26,160 | 52.8 | 23,412 | 47.2 | 49,572 | 100.0 |
| 2010/2011 | 43,191 | 84.8 | 7,735 | 15.2 | 50,926 | 100.0 |

Table 3.4 Diagnosis codes from CHADx class 12 with an ICD type of other diagnoses by *Condition Present on Admission* value.

| Year | Other Diagnoses | | | | | |
|-----------|----------------------|------|-------------------|------|-----------------|-------|
| | Present on Admission | | Hospital-Acquired | | All CPoA values | |
| | N | % | N | % | N | % |
| 2006/2007 | 7,741 | 39.2 | 12,020 | 60.8 | 19,761 | 100.0 |
| 2007/2008 | 8,615 | 40.6 | 12,599 | 59.4 | 21,214 | 100.0 |
| 2008/2009 | 9,162 | 38.0 | 14,982 | 62.1 | 24,144 | 100.0 |
| 2009/2010 | 9,232 | 35.3 | 16,928 | 64.7 | 26,160 | 100.0 |
| 2010/2011 | 15,804 | 36.6 | 27,387 | 63.4 | 43,191 | 100.0 |

Table 3.4 further breaks down the class 12 diagnoses that were assigned as *other diagnoses* by CPoA value (*present on admission* or *hospital-acquired*). Despite the extra diagnoses in 2010/2011, the proportion of diagnoses coded as *hospital-acquired* is consistent with the proportion in preceding years. Hence the increase in class 12 in 2010/2011 can be attributed to the additional *other diagnoses* obstetric codes that were assigned as *principal diagnosis* prior to 2010/2011; these additional *other diagnoses* obstetric codes in turn result in additional *hospital-acquired* obstetric codes.

3.4 Obstetric and Perinatal Classes

The CHADx is composed of 17 classes covering all diagnoses that may be acquired in hospital. Several of these classes represent conditions that are obtained in hospital and are likely the result of the care they received in hospital. Most notable among these are several sub-classes from classes 1 (*post-procedural complications*), 3 (*accidental injuries*), 4 (*specific infections*) and 8 (*skin conditions*) (see Section 4.0). Generally, if a patient experiences a condition from these classes the hospital will likely be responsible to some extent.

Conversely, there are some CHADx classes whose conditions are not necessarily attributable to the hospital in which they arose, even though they arose while the patient was in hospital. CHADx classes 12 (*labour, delivery and postpartum complications*) and 13 (*perinatal complications*) are most noteworthy among these. For example, while giving birth a patient could develop a perineal tear (ICD-10-AM code O70, included in CHADx class 12). However, the tear could conceivably have occurred whether the patient was in hospital or not. Similarly, a newborn that experiences respiratory distress (ICD-10-AM code P22, included in CHADx class 13) may do so regardless of the treatment administered in hospital. Class 13 is further highlighted because it is the only CHADx class whose definition allows for both hospital-acquired *and* 'present on admission' conditions. That is, a condition will be counted in class 13 regardless of its *Condition Present on Admission* value, whereas all other classes require that a condition must be flagged as *hospital-acquired*.

Table 3.5 and Table 3.6 present the 10 most frequent ICD-10-AM diagnosis codes in 2010/2011 from CHADx classes 12 and 13 respectively. For class 12, the 10 most frequent ICD-10-AM codes constitute 70% of the entire class, while for class 13 the 10 most frequent codes constitute 57%. It is important to note that, in general, the listed diagnoses cannot be attributed to a hospital with certainty.

In a review of the CHADx classification its authors noted the following regarding obstetric and perinatal conditions:

We included in the CHADx all other obstetric and perinatal conditions that could plausibly be attributed to the care received in hospital, despite the possibility of the condition arising prior to the formal admission.¹⁰

In the same review, the authors further justified the inclusion of perinatal conditions:

For perinatal admissions it will be necessary to continue including conditions that are present on admission as, although many conditions may not have arisen in hospital, they are still of interest to obstetricians, neonatologists and midwives.¹⁰

As a result, CHADx obstetric classes 12 and 13 should be interpreted with caution, especially since a large number of hospital-acquired diagnoses are attributed to class 12. This does not necessarily indicate that hospitals administer poor care for obstetric patients. Rather, it highlights that obstetric patients are more prone to complications.

Table 3.5 Counts and percentages of the 10 most frequent ICD-10-AM diagnoses from CHADx class 12: labour, delivery and postpartum complications, 2010/2011.

| Class 12: Labour, Delivery and Postpartum Complications | | | | |
|---|--|-----------------------------|------------|--------------|
| ICD-10-AM diagnosis code | | Hospital-acquired diagnoses | % of class | Cumulative % |
| 070.1 | Second degree perineal laceration during delivery | 6,633 | 24.2 | 24.2 |
| 072.1 | Other immediate postpartum haemorrhage | 2,797 | 10.2 | 34.4 |
| 070.0 | First degree perineal laceration during delivery | 2,113 | 7.7 | 42.1 |
| 068.0 | Labour and delivery complicated by fetal heart rate anomaly | 1,974 | 7.2 | 49.4 |
| 069.8 | Labour and delivery complicated by other cord complications | 1,537 | 5.6 | 55.0 |
| 071.82 | Diastasis of recti abdominal muscle in pregnancy or delivery | 1,096 | 4.0 | 59.0 |
| 068.8 | Labour and delivery complicated by other evidence of fetal stress | 831 | 3.0 | 62.0 |
| 068.2 | Labour and delivery complicated by fetal heart rate anomaly with meconium in amniotic fluid | 762 | 2.8 | 64.8 |
| 070.2 | Third degree perineal laceration during delivery | 746 | 2.7 | 67.5 |
| 092.20 | Other and unspecified disorders of breast associated with childbirth, without mention of attachment difficulty | 741 | 2.7 | 70.2 |

Table 3.6 Counts and percentages of the 10 most frequent ICD-10-AM diagnoses from CHADx class 13: perinatal complications, 2010/2011.

| Class 13: Perinatal Complications | | | | |
|-----------------------------------|--|-----------|------------|--------------|
| ICD-10-AM diagnosis code | | Diagnoses | % of class | Cumulative % |
| P70.4 | Other neonatal hypoglycaemia | 1,223 | 9.2 | 9.2 |
| P22.0 | Respiratory distress syndrome of newborn | 1,138 | 8.5 | 17.7 |
| P59.0 | Neonatal jaundice associated with preterm delivery | 1,071 | 8.0 | 25.8 |
| P22.1 | Transient tachypnoea of newborn | 993 | 7.5 | 33.2 |
| P92.8 | Other feeding problems of newborn | 946 | 7.1 | 40.3 |
| P29.1 | Neonatal cardiac dysrhythmia | 535 | 4.0 | 44.3 |
| P28.83 | Grunting in newborn | 470 | 3.5 | 47.9 |
| P59.9 | Neonatal jaundice, unspecified | 455 | 3.4 | 51.3 |
| P28.41 | Apnoea of prematurity | 438 | 3.3 | 54.6 |
| P92.0 | Vomiting in newborn | 331 | 2.5 | 57.1 |

4.0 CHADx Adverse Events in Queensland Health

Within the CHADx classification, there is a small selection of CHADx sub-classes (Table 4.1) whose conditions can be considered as ‘adverse events’ i.e. incidents where avoidable harm has occurred to a person receiving health care in a hospital setting. If a patient receives such an adverse event during their hospital stay, it is likely that the hospital is somewhat responsible.

In Queensland Health in 2011/12, this subset of definitions from the CHADx classification was used to produce monthly reports on the number of adverse events in several Queensland hospitals. These reports were used to identify adverse patient episodes and consequently impose financial penalties as part of the 2011/12 Queensland Health Purchasing Framework. CHADx has not been used in the 2012/13 Purchasing Framework as a more comprehensive method has been used to identify safety and quality purchasing priorities.

Table 4.1 Selected sub-classes of the CHADx classification whose conditions are considered as adverse events.

| CHADx Class | CHADx Sub-class |
|----------------------------------|--|
| 1. Post-procedural complications | 1.6 Foreign body or substance left following a procedure |
| | 1.9 Wound infection (excluding sepsis) |
| 3. Accidental Injuries | 3.1 Falls with fractured femur |
| | 3.2 Falls with intracranial injury |
| | 3.3 All other falls |
| 4. Specific Infections | 4.1 Sepsis |
| | 4.3 Methicillin resistant agent |
| | 4.4 Other drug resistant infections |
| | 4.5 Other infectious agents |
| 8. Skin Conditions | 8.1 Pressure ulcers |

It is noted that the use of the CHADx (albeit a small subset) for this purpose conflicts with the original motivations of the CHADx authors, who did not intend for the CHADx to be used for external monitoring or holding hospitals to account.²

5.0 Comparison of CHADx with similar schemes

The CHADx is a relatively new classification, and is the first that attempts to comprehensively capture hospital-acquired conditions in ICD-10-AM. However, there are several previous classifications that also attempted to capture hospital-acquired conditions in administrative data settings, although their motivations for doing so varied.

In 2002, an expert panel of health professionals finalised a classification of adverse events for the Utah/Missouri Patient Safety Project.¹¹ The panel sought to identify adverse events based on the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) with the purpose of aiding the Safety Project’s review criteria. At the time, there was no *Condition Present on Admission* variable available so that adverse events had to be identified at the ICD-9-CM code level, largely restricting the scope of the classification. That is, diagnosis codes were included only upon the basis that the code was likely to arise in hospital. The final classification consisted of 66 classes, based

around 'misadventures of surgical and medical care', 'complications of surgical or medical procedures' and 'adverse drug events'. The CHADx, with the use of the CPoA variable, considerably expands upon this class listing, while also offering a classification in the more recent ICD-10-AM.

Another hospital monitoring tool that is particularly relevant to Queensland Health is the Variable Life Adjusted Display (VLAD).¹² The VLAD was adopted by Queensland Health in 2007 with the purpose of monitoring a variety of patient outcomes relating to complications of surgery, patient readmission, in-hospital mortality and length of stay. These outcomes share no commonality with the CHADx class definitions, although some pertain to complications of surgery and obstetrics. Additionally, the VLAD is focused on patient outcomes, and identifies facilities that have more or less outcomes of interest than expected for investigation. For this purpose, the VLAD system incorporates risk adjustment to ensure results are not biased against hospitals that admit older and sicker patients.

In 2006, 3MTM Health Information Services developed a system to identify potentially preventable complications (PPC) in California hospitals¹³. The system was developed to assist funding directives and as such employs risk adjustment to facilitate comparisons between hospitals. It has since been used in several studies to evaluate the costs of hospital complications for several facilities in California, Maryland and New York¹⁴⁻¹⁷. The PPC system is similar to the CHADx in the sense that it utilises a present on admission (PoA) indicator and arranges diagnoses into mutually exclusive complication classes, although the classification is not as comprehensive as the CHADx. Additionally, the system was developed in ICD-9-CM and, as a result, is not appropriate for use with administrative data in Australia where ICD-9-CM is now obsolete.

The CHADx can therefore be distinguished from previous hospital-acquired classification/monitoring systems in two key ways: (1) The CHADx offers the most comprehensive classification of hospital-acquired diagnoses in ICD-10-AM to date; and (2) The CHADx was not intended to be used as an external monitoring tool; it was designed for use *within* hospitals to monitor hospital-acquired diagnoses.

6.0 Recommendations

Currently, there is little information available to Queensland (and Australian) facilities regarding hospital-acquired diagnoses. The CHADx is the most thorough classification of hospital-acquired conditions to date, and provides facilities with a tool to keep track of in-patient harm. The adoption of the CHADx would enable facilities to monitor harm events on a monthly basis, thereby flagging when the facility performs poorly and highlighting specific areas for quality improvement. As noted by the CHADx authors, this would only be possible with the assumption of constant casemix in a facility from month to month.¹⁰

Potentially, with the implementation of risk adjustment, the CHADx could be used to monitor the performance of facilities in a similar way to the VLAD or 3MTM PPC, with the various classes of the CHADx constituting performance indicators. Such a system would allow each hospital to be measured against the performance of all Queensland hospitals, with under (or over) performing hospitals being flagged for further investigation. Additionally, the inclusion of risk adjustment would remove the need for an assumption of constant casemix within a facility. However, before such a system could be developed, the quality of the *Condition Present on Admission* variable would need to be improved upon to ensure reliable reporting, and for this purpose data validations have already been implemented. In

addition, clinical review of the CHADx may be required to evaluate the validity of conditions included as 'hospital-acquired' depending on the purpose for which the CHADx is employed.

Hence, the CHADx, as it is currently defined, is only appropriate for the task for which it was originally conceived: a tool for hospitals to monitor in-patient injury and illness. For this purpose, it is comprehensive and without rival, but there is scope for expanded usefulness with further work.

7.0 Acknowledgements

The authors would like to acknowledge Sandra Martyn and Stephanie Callaghan for their contributions to the design and analysis of this technical report, and Margaret Campbell for her work in mapping the CHADx definitions across ICD-10-AM editions.

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9.0 Appendix

The CHADx is composed of an extensive list of definitions that specify which diagnoses should be assigned to which class and subclass. CHADx version 4.1 definitions were utilised in this report, although version 4.2 has since been released and is available from the *Australian Commission on Safety and Quality in Health Care* website. Across the 17 classes, there are some definitions and rules which become problematic when applied to the QHAPDC data. Additionally, there were some alterations made to the CHADx algorithm in order to improve its legitimacy. Any notable changes are listed below:

9.1 Infections

The definitions for several classes (1, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16 and 17) of the CHADx include the following rule, regarding infections:

Where a code for infection or infective process is followed by a sepsis code in Class 4.1, count the infection in the relevant class in this chapter

Essentially, this rule is intended to ensure that each infection is only counted once. For example, if a patient has an infection which develops into sepsis, the early infection (as opposed to the sepsis) should be identified. The difficulty is that, where this rule is described, the CHADx does not specify which ICD-10-AM codes constitute an *infection* or *infective process*. As a result, this rule was not applied in this analysis, so that both the early infection *and* the more serious sepsis infection were identified. This approach is suggested by *Australian Commission on Safety and Quality in Health Care* in the more recent version (4.2) of the CHADx.

9.2 Diagnosis Code Sequencing in QHAPDC

Diagnosis information for each QHAPDC patient episode is entered in a specific sequence. The principal diagnosis is always sequenced first, followed by any external causes or morphology codes which may be relevant to the principal diagnosis. Every admitted episode must have at minimum a principal diagnosis assigned. If a patient has any other diagnoses that meet the criteria for coding, these are sequenced next as additional (or other) diagnoses, again with any relevant external causes or morphology codes following. The relationship between diagnosis codes and external causes is significant to many classes of the CHADx, where diagnosis code sequencing is used to define hospital-acquired conditions. For example, CHADx subclass 3.1 *falls with fractured femur* specifies that ICD-10-AM S72 *fracture of femur* is to be included only when followed by a fall related external cause (such as ICD-10-AM W06 *fall involving bed*). The use of the codes together would then constitute a *fractured femur resulting from fall involving bed*.

The QHAPDC sequencing rules do not allow for codes to be assigned more than once per episode. This excludes instances where the external cause code is assigned to both a principal and additional diagnosis code. In situations where an external cause is relevant to several additional diagnosis codes, the external cause code is sequenced once after the group of diagnosis codes to which it applies, as opposed to being listed once after each diagnosis code. Additional diagnoses that do *not* require an external cause code should then be sequenced after additional diagnoses that *do* require an external cause code.

However, the order in which diagnosis codes are sequenced in QHAPDC does not often comply with sequencing guidelines. This makes it difficult to determine how many of the preceding diagnosis codes that an external cause code is actually relevant to. This analysis assumes that diagnosis sequencing for each episode fully complies with QHAPDC sequencing rules: i.e. an external cause was assumed to be relevant to the entire group of preceding diagnosis codes.

9.3 Adverse drug events

Within class 2 (adverse drug events) of the CHADx, the definitions for several subclasses (2.2, 2.4, 2.6, 2.9, 2.10, 2.13 and 2.15) specify a wide range of ICD-10-AM diagnosis codes (*A00-R99 and T80, excluding R11*) for inclusion, with the added restriction that the diagnoses are followed by a relevant external cause code (see CHADx definition list⁴ for specific details).

Due to incorrect diagnosis code sequencing in QHAPDC (see Section 9.2) it is possible for an external cause code to be applied to an inappropriate preceding diagnosis code. For example, a diagnosis of diabetes (ICD-10-AM E09.x-E14.x) would be included in class 2 if it was mistakenly sequenced before an external cause that was relevant to an adverse drug event. The problem with including diagnosis codes such as diabetes in class 2 is that they are: (1) not hospital-acquired; and (2) not an adverse drug event.

To account for this potential problem, counts of high frequency chronic conditions were removed from class 2, including ICD-10-AM diagnoses of *Diabetes* (E09.x-E14.x), *Chronic Lower Respiratory Diseases* (J40.x-J47.x) and *Chronic Kidney Disease* (N18.x).