Using ICD-10-AM codes to characterise hospital-acquired complications

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Abstract

This paper describes the limitations of using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) to characterise patient harm in hospitals. Limitations were identified during a project to use diagnoses flagged by Victorian coders as hospital-acquired to devise a classification of 144 categories of hospital acquired diagnoses (the ***C***lassification of ***H***ospital ***A***cquired ***D***iagnoses or CHADx). CHADx is a comprehensive data monitoring system designed to allow hospitals to monitor their complication rates month-to-month using a standard method. Difficulties in identifying a single event from linear sequences of codes due to the absence of code linkage were the major obstacles to developing the classification. Obstetric and perinatal episodes also presented challenges in distinguishing condition onset, that is, whether conditions were present on admission or arose after formal admission to hospital. Used in the appropriate way, the CHADx allows hospitals to identify areas for future patient safety and quality initiatives. The value of timing information and code linkage should be recognised in the planning stages of any future electronic systems.

Keywords (MeSH):

ICD Codes; Data Interpretation, Statistical; Coding; Postoperative Complications; Obstetric Complications.

Background

Use of routinely collected hospital data for patient safety analyses is a growing trend. Originally designed to record causes of death, the International Classification of Diseases (ICD) has now become an international standard diagnostic classification for morbidity recording. More recently, due to the international adoption of 'present on admission' or 'condition onset' flags on diagnoses codes, ICD is used to classify hospital-acquired injury and illness. Australia, Canada and the US have now adopted the practice of assigning a flag to most or all diagnosis codes to reflect the timing of onset of a condition.

Prior to the introduction of condition onset flagging, patient safety researchers focused on using ICD coding with elaborate risk-adjustment methods to reduce confounding of comorbidities (present on admission) and complications (conditions arising in hospital). The approach was to limit the patient population to 'risk pools' with similar risks of adverse events and their consequences (Iezzoni et al. 1994, 1999; Weingart et al. 2000). This was designed to ensure that external monitoring of patient injury rates did not penalise institutions admitting sicker or more vulnerable patients.

Most such research efforts have utilised ICD-9-CM (Clinical Modification), the version in use in the US, to develop classifications of hospital-acquired conditions. The 'Potentially Preventable Complications' (PPCs) development team used the 'condition onset' indicator in two ways; to identify complications for inclusion into the PPC system through codes flagged 'not present on admission', and to identify conditions flagged 'present on admission' for risk adjustment (Hughes et al. 2006). Some PPC's also consider procedure codes to distinguish more serious complications, for example obstetrical haemorrhage with transfusion vs. obstetrical haemorrhage without transfusion.

The Utah/Missouri ICD-9-CM Adverse Event Classification was not designed for use with the 'condition onset' flag and although the purpose was to act as a surveillance tool, it includes mainly adverse events that are explicitly the result of medical care (Utah/Missouri Patient Safety Consortium 2002). Other smaller sets of 'indicators' exist, such as the AHRQ Patient Safety Indicators (PSIs) (Agency for Healthcare Research and Quality 2006), and Queensland Health's Variable Life Adjusted Displays (VLADs) (Duckett, Coory & Sketcher-Baker 2007) and these are used to assess the quality of care given by providers. The emphasis of these indicators is to identify '*preventable* harm' and, therefore, they do not encompass the full range of conditions that can arise in hospital, nor the changing nature of 'preventability' over time.

Development of an alternative

Our use of the routinely coded data was different from the previous research, and sought to develop a tool to allow hospitals to monitor their own rates of adverse patient outcomes, for the full range of codes which can be hospital-acquired, regardless of preventability status. The 'Classification of Hospital-acquired Diagnoses' (CHADx) was developed by first identifying all codes flagged as a complication in the Victorian Admitted Episodes Dataset (VAED) 2005/06 (Jackson et al., in press). A data cleaning algorithm, developed in tandem with the CHADx, was used to remove codes that should never be designated as hospital-acquired due to the chronic or congenital nature of the condition (Jackson et al., submitted for publication). Following this, the remaining codes were grouped into meaningful categories for patient outcome monitoring purposes based on the volume of cases and the seriousness of the condition. A clinical panel, formed for the purpose of this project, reviewed each group and offered valuable clinical advice.

The end product of 144 detailed classes and 17 'roll-up' groupings allows hospitals to monitor their complication rates month to month using a standard method. Hospitals may choose to compare or 'bench mark' the complication rates with comparable hospitals, but its primary use is to track performance over time within the facility, assuming no major change to the casemix of the patients. CHADx is a comprehensive monitoring system for all hospital-acquired harms validly identified by the 'condition onset' flag. The aim of this paper is to describe the limitations we encountered in using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) to characterise patient harm in hospitals.

The problem with ICD-10-AM coded data: identifying a hospital-acquired 'event'

The primary problem with using ICD-10-AM is not due to the classification system itself but due to the way the data is entered and stored in hospital computer systems. Current Australian coding systems allow only a linear entry of codes with relative order indicating some relationships amongst diagnosis codes, but leaving much ambiguity. Combinations of two or more codes are often used to describe a single hospital-acquired adverse event; however, such combinations are frequently interpreted as multiple events.'

Codes entered into hospital electronic information systems for each episode are stored as a single continuous line of codes, and therefore combinations of codes do not retain any association. The sequence in which the codes are entered enables interpretation of some events, supported by coding standards for specific code combinations, but is unreliable for others. Multiple coding occurs in situations where more than one code is required to represent the various components of a diagnosis (the 'medical statement') (National Centre for Classification in Health 2006). In relation to hospital-acquired conditions, multiple coding is used for coding postprocedural complications, injury and adverse effects due to treatment, and hospital-acquired infections. The Australian Coding Standards and the ICD-10-AM Tabular list guide coders on when to add and how to sequence the additional codes.

Queensland attempts to retain code association by instructing coders to code all external cause related events first in the string of codes (after the principal diagnosis) (Data Services Unit [DSU] Queensland Health 2006). This means all codes sequenced between the external cause code

and the principal diagnosis, or a previous external cause related code, are linked. This relies substantially on hospital and coder compliance as it is not subjected to code edits or data audit.

The aim of the CHADx was to capture all hospital-acquired conditions while avoiding double counting of an 'event'. A hospital-acquired event represented by more than one code could result in it being counted more than once. Rules were developed to overcome this problem but coding errors and computer system inadequacies hindered the process. Obstetric and perinatal episodes also posed a problem, as for many diagnoses it was difficult to establish the timing of onset. This is explained in more detail later.

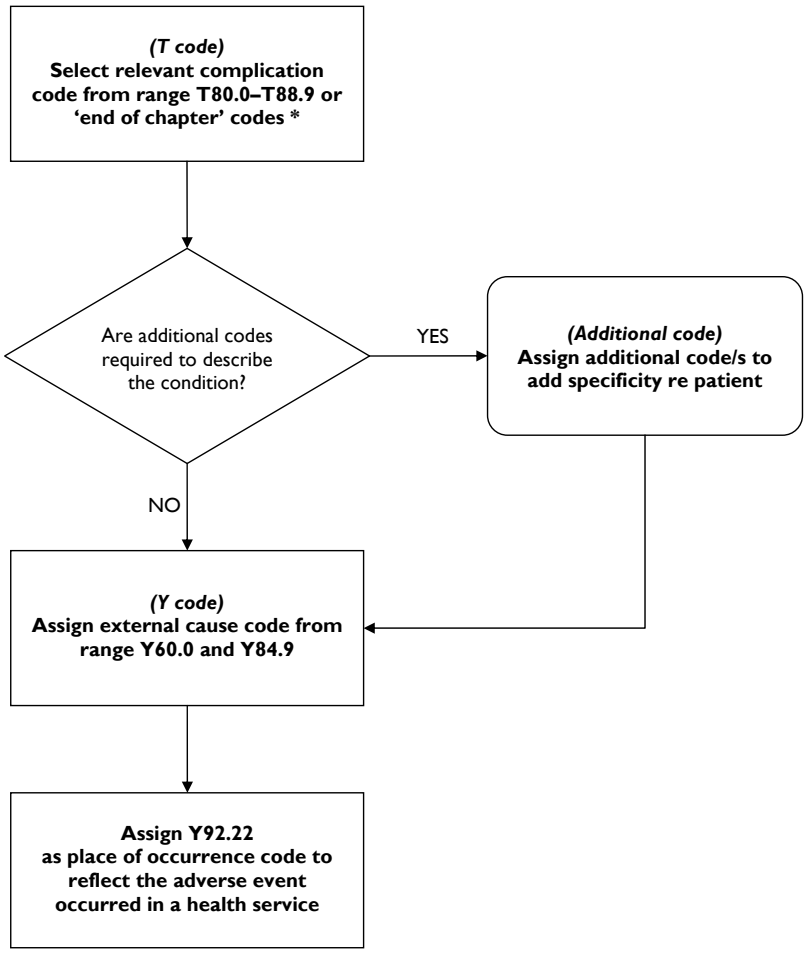

Figure 1: Process of assigning codes for postprocedural complications as per the Australian Coding Standards

* End of chapter codes although not represented by a 'T' code are referred to as 'T code' in this figure

Postprocedural complications

Postprocedural events head the CHADx as the first major category. Coding standards require that postprocedural complications always be represented by three or more codes as shown in Figure 1.

In designing the CHADx, it was decided that the manifestation code (*T* code in Figure 1) should be the defining code for postprocedural complications as it describes both the type of harm to the patient and indicates it was a result of medical or surgical care. Problems arose in the development stage of this major CHADx when the order of codes was incorrect, or due to the sequencing of codes in different ways when there were 'multiple' adverse effects due to 'one or more' adverse events. The following sequences could be found in the routine data *(note: 'A' represents additional code/s; place of occurrence codes are not represented below):*

1) TT(A)Y
2) T(A)YT(A)Y
3) T(A)T(A)YY

Sequences (1) and (2) above are the least ambiguous and are able to be interpreted for the purposes of patient safety and research. Sequence (3) from a data user point of view is more difficult to interpret as there are multiple manifestations and causes to match. In the absence of code linkage, the CHADx algorithm was programmed to locate the first 'Y' code which follows a 'T' or 'End of Chapter' (Jackson et al. 2006) code to identify code combinations. Once such code combinations were identified, the program allocated the defining code to the relevant CHADx category and excluded the remaining codes in the combination. Thus, in the examples above, the first and third define the event using the first 'T' code only, losing information about the second recorded 'T'. The second example is counted more straightforwardly as two separate 'events' bracketed by 'T' and 'Y' codes.

CHADx logic: Postprocedural complications are classified according to the initial manifestation code ('T' or 'End of Chapter' code (EOC)); additional codes sequenced after the 'T' and 'EOC' codes plus the compulsory external cause code are excluded from allocation to avoid possible double counting.

Injury and adverse effect of drugs

Injuries and adverse effects of drugs are coded in a similar way to postprocedural codes; however, they do not have the initial complication code which was used as the defining code for postprocedural events. If multiple adverse effects occur for a single drug, it is currently impossible to attribute all the effects to the drug, due to the absence of a defining initial code in the string (as in the 'T' code example above) or an indicator to link all the codes. Therefore, in the following scenario it is only possible to definitively link the diagnosis code which immediately precedes the external cause code with the external cause. To a data user, the nausea may be due to the diuretic or it may be a completely separate event in the patient episode.

R11 (*Nausea*) + R51 (*Headache*) + Y54.5 (*due to diuretics*)

CHADx logic: Injuries and adverse effects of drugs are classified according to the cause of injury, for example type of drug, fall, or burn, as it is the most relevant information for patient safety efforts. The diagnosis code immediately prior to the external cause which describes the adverse effect is not separately recorded, to avoid double counting the 'event'. Any other codes used to describe the adverse effect or injury, that is, those which do not appear immediately prior to the external cause code, cannot be linked with the external cause and are classified according to the manifestation in other CHADx classes. Therefore, more than one manifestation code unavoidably leads to multiple counting of the 'event' because of ambiguity about the relationship amongst the codes.

Hospital-acquired infections

In discussions with patient safety clinicians, septicaemia was identified as one of the few conditions that should always be assigned to the relevant CHADx (regardless of concerns about double-counting) because of its seriousness and importance in patient safety monitoring. Thus, any code representing septicaemia is assigned to the 'septicaemia' category and takes precedence even over postprocedural complication codes.

Infections arising in hospital are often represented by at least two codes, one for the site of infection plus one for the infective agent or bacterium. In the following scenario three codes represent one infection: the bacterium *Klebsiella pneumoniae* has caused a urinary tract infection which has progressed to septicaemia. The scenario is represented by the codes below and, without explicit code linkage, must give rise to double counting, if all septicaemia is to be captured. In the example below, the site infection (*Urinary Tract Infection*) is assigned to a CHADx within 'Genitourinary Complications' and sepsis is assigned to 'Septicaemia'. The code representing the bacterium *Klebsiella pneumoniae* is excluded as this code is not to be used on its own, and thus would represent double counting as the 'event' is classified elsewhere.

N39.0 (*Urinary Tract Infection*) + A41.8 (*Sepsis*) + B96.1 (*Klebsiella pneumoniae)*

CHADx logic: The infection codes are all classified into the relevant CHADx with the exception of codes representing the infective agent. Codes representing purely infective agents cannot be used singularly and are excluded from allocation. The expectation is that hospitals experiencing dramatic changes in the rates of septicaemia, or other hospital-acquired conditions due to infectious agents, would 'drill down' through records of affected cases, review pathology reports, or manually review patient records, to identify any specific organisms.

There are two instances where CHADx purposefully double counts an event. Drug resistant infections and anaphylactic shock due to the administration of drugs were considered too important to not consider independently. Drug resistant infections are shown in both the 'drug resistant infection' category (Z06.- range) and the relevant 'infection' category (wound infection, pneumonia, UTI, etc.) (Jackson et al., in press). Anaphylactic shock cases appear in both 'anaphylactic shock due to correct drug properly

administered' (T88.6; T78.2 when followed by Y40-59) and the associated drug category/s (Y40-59) (Jackson et al., in press). The coded instances of anaphylactic shock may be few, but separate identification of these cases was considered to be important for patient safety monitoring.

Causal/co-existing relationships

With better code linkage, further coded conditions could be selectively excluded from the CHADx on the basis that they are recorded only due to the presence of another condition. The ICD-10-AM Australian Coding Standards has a convention for dual coding some manifestation and underlying cause combinations called the 'dagger and asterisk' system (National Centre for Classification in Health 2006). However, to establish other causal links clinical coders must be explicitly guided by the medical record documentation, and many causal links can be difficult to determine, even for clinicians. It is unlikely that code linkage would overcome this hurdle in the future. However, rules can be established for common combinations to avoid double counting when identified by data programs. In developing the CHADx, we considered it inappropriate to count a hospital-acquired condition if known to be caused by, or co-exist with, another hospital-acquired condition.

CHADx logic: The CHADx has adopted rules, following advice from the clinical panel, for a small number of conditions which co-exist or have a direct causal link (i.e. manifestations are attributed to the underlying cause); examples include:

- Specific electrolyte disorders, for example Hypokalaemia, are not double counted if dehydration is coded in the same episode;
- 'Deep Vein Thrombosis' is not separately counted if 'Pulmonary Embolism' is coded in the same episode.

Timing of obstetric and perinatal related conditions

The CHADx was developed using the VAED from 1 July 2005 to 30 June 2006. For this time period, the Victorian Additions to the Coding Standards guided coders to flag all obstetric codes as present on admission (Health Data Standards and Systems Unit 2005), preventing hospital-acquired events from being identified by means of the condition onset flag. There was no special guidance for perinatal coding, so neonatal conditions present at birth were appropriately flagged as present 'on admission'. However, this practice means conditions of interest to the hospital, for example *Injury due to birth trauma,* occurring during the admission but prior to the birth are not identifiable solely from codes designated 'not present on admission'.

For obstetric coding the situation has changed incrementally. For the period 2006/07 the Victorian guidance was for conditions arising after the end of the second stage of labour to be flagged as 'not present on admission', with the exception of the principal diagnosis (Health Data Standards and Systems Unit 2006). However, from 1 July 2007 Victoria changed the rules for assigning the condition onset flag to treat obstetric codes the same as other diagnosis codes, (Health Data Standards and Systems Unit 2007) following the national 'condition onset' standard.

For the CHADx project, we reviewed all diagnosis codes from the obstetric and perinatal ICD chapter, and subsequently excluded those diagnoses most likely to be pre-existing on the patient's admission to hospital. 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.

Given the coding rules in Victoria at the time, the incidence of many of the obstetric complications may have been overstated by the first version of the CHADx. A revised version of CHADx, for use with data later than 1 July 2007, will count only codes designated as 'not present on admission'. The one exception may be the principal diagnosis code, if this is a valid CHADx code, as the principal diagnosis in obstetric cases may be a condition that arose after admission.

For perinatal admissions it will be necessary to continue including conditions that are present on admission as, although many newborn conditions may not have arisen in hospital, they are still of interest to obstetricians, neonatologists and midwives. The complication rates of the perinatal categories will help monitor the number of complicated births that occur with the view to identifying future research and resourcing depart-

ments to improve the care of these patients or reduce the number of complicated births in the future.

CHADx logic:

- **Obstetric:** Valid hospital-acquired conditions flagged as 'not present on admission'or coded as the principal diagnosis are included (not applicable to Victorian data prior to July 2007).
- **Perinatal:** Valid hospital-acquired conditions flagged as 'present on admission' or 'not present on admission' are both included.

Discussion: implications for patient safety monitoring systems

Due to current system deficiencies and coding variance there are implications for using ICD-10-AM codes for patient safety monitoring. We believe the benefit of being able to monitor the full range of hospital-acquired conditions using the CHADx is outweighed by the probability of double-counting some 'events' that would overstate the rate of specific complications. Other patient safety classifications using routine hospital diagnosis data have a lower risk of overcounting but substantially undercount, by not including all hospital-acquired conditions (focusing on a narrower range of 'indicators' or 'potentially preventable' diagnoses).

In order to incorporate all hospital-acquired diagnosis codes into the CHADx, residual classes with lesser granularity were created to accommodate multiple less serious conditions enabling more serious and high volume conditions to take priority. The CHADx is a valuable tool for hospitals in its current form, but will obviously require revision as changes to source codes, coding rules and additional edits are adopted. Changes to methods for code linkage to identify an 'event,' would improve the classification. Future users of the CHADx will need to be mindful of the limitations raised in this paper.

For drug induced events, the code which describes the drug responsible for the adverse effect is prioritised and manifestations counted only when they are not the immediately preceding code. Multiple manifestations may arise from one drug event, but only the manifestation code prior to the external cause code is able to be linked. Therefore, multiple counting of the event may take place when further manifestations are assigned to separate CHADx classes.

Obstetric complications are overcounted by the current version of CHADx due to the inclusion of conditions flagged as present on admission. It should be noted that this does not necessarily affect the 'rate' of obstetric complications (proportion of cases with any hospital-acquired condition), but may inflate the count of such conditions when several are recorded for the same episode. Overcounting would continue in the future if a revised version of CHADx assigned principal diagnosis codes. This course may be necessary due to the likelihood of obstetric episodes having a hospital-acquired condition as the principal diagnosis, when no codable condition is recorded as present on admission. This will result in a confusion of incident cases if patients are readmitted for the same principal diagnosis.

It is quite difficult to obtain an accurate picture of hospital-acquired perinatal conditions from the routine data. Including valid CHADx codes flagged as present on admission will overestimate the complication rates for newborns as some of the conditions may not be hospital-acquired. The disease process may have been initiated prior to the mother's admission to hospital or, as for obstetric principal diagnoses, a newborn may be readmitted with the same diagnosis.

Future directions

For many years there has been discussion in coding circles about better ways to link sequential ICD codes, or ICD diagnosis and procedure codes together. It has been suggested that a matrix style of coding, where codes are entered into a matrix with each row representing all the codes associated with one condition or event, would better suit the relational nature of diagnosis and procedure information. All procedures, as well as associated diagnosis codes, would be entered on the same line as the treated condition, and thus could be considered as a single 'event'. Procedure codes from The Australian Classification of Health Interventions (ACHI) could combine with diagnosis codes in future versions of the CHADx to identify more serious complications, as in the earlier mentioned PPC's.

The benefits of matrix coding to hospital managers and researchers would be considerable, as routine data users would have the capability to accurately monitor patient safety events and conduct more useful research. However, a change of this size would require significant modifications to be made to hospital computer systems and software, coding practice and medical documentation entries. State and local health authorities may be reluctant to make such changes with implementation of an electronic health record (EHR), also requiring major system changes, likely in the near future. EHRs may have the functionality to link codes and maintain a sequence of events (or time stamps for diagnoses and procedures) in each patient episode.

If health authorities are reluctant to make major changes to health information systems, alternative solutions should be considered in the interim. One option would be assigning an indicator flag to link associated diagnosis codes together, that is 'a' to the first set of codes, 'b' to a second set of codes, etc. However, with the recent introduction of the condition onset flag, assigning another indicator to each diagnosis code may be resisted because of the additional burden on coding staff and related expense. Modifications to coding conventions such as allowing repetition of Y codes so that each 'bundle' of codes for a procedural complication starts with a T or an EOC code and ends with a Y code (other than place of occurrence code), and using a T code to lead all adverse effect of drugs combinations, are other suggestions that might be considered as interim measures.

Conclusion

The classification of hospital-acquired diagnoses was developed to make best use of the valuable resource of routine hospital diagnosis coding to improve patient safety in hospitals. Used with some understanding of the limitations imposed on the CHADx by the underlying ICD-coded data, the classification will allow hospitals to monitor complication rates and identify areas for future patient safety and clinical outcome initiatives. Data users need to be properly informed to interpret the rates of individual CHADx (being cognizant of the logic designed to reduce double counting) to ensure accurate and useful information for patient safety workers. This is important for continuous quality improvement activities aimed at reducing hospital adverse outcomes and improving patient care. Depending on the timing of the introduction of the electronic health record, now may not be the time to introduce radical changes to coding systems and standards. However, the value of timing information and code linkage should be recognised in the planning stages of any future electronic systems.

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References

Agency for Healthcare Research and Quality (2006). *AHRQ quality indicators: patient safety indicators overview*. Rockville, MD. Available at: http://www.qualityindicators.ahrq.gov/psi_overview.htm (accessed 9 Feb 2009).

Data Services Unit [DSU] Queensland Health (2006). *2006-2007 Queensland Hospital Admitted Patient Data Collection (QHAPDC): manual of instructions and procedures for the completion of patient identification and diagnosis data: Appendix L*. Available at: http://www.health.qld.gov.au/hic/qhapdc2006/QHAPDC_Manual_0607.pdf (accessed 24 Nov 2008).

Duckett, S.J., Coory, M. and Sketcher-Baker, K. (2007). Identifying variations in quality of care in Queensland hospitals. *Medical Journal of Australia* 187(10): 571-575.

Health Data Standards and Systems Unit (2005). *Victorian additions to Australian Coding Standards, Victoria*. Available at: http://www.health.vic.gov.au/hdss/icdcoding/vicadditions/vicadd05.pdf (accessed 3 March 2008).

Health Data Standards and Systems Unit (2006). Victorian Additions to Australian Coding Standards, Victoria. Available at: http://www.health.vic.gov.au/hdss/icdcoding/vicadditions/vicadd6.pdf (accessed 13 Feb 2009).

Health Data Standards and Systems Unit 2007, Victorian Additions to Australian Coding Standards, Victoria. Available at: http://www.health.vic.gov.au/hdss/icdcoding/vicadditions/vicadd07.pdf (accessed 13 Feb 2009).

Hughes, J.S., Averill, R.F., Goldfield, N.I., Gay, J.C., Muldoon, J., McCullough, E. and Xiang, J. (2006). Identifying potentially preventable complications using a present on admission indicator. *Health Care Financing Review* 27(3): 63-82.

Iezzoni, L.I., Daley, J., Heeren, T., Foley, S.M., Fisher, E.S., Duncan, C., Hughes, J.S. and Coffman, G.A. (1994). Identifying complications of care using administrative data. *Medical Care* 32(7): 700-15.

Iezzoni, L.I., Davis, R.B., Palmer, R.H., Cahalane, M., Hamel, M.B., Mukamal, K., Phillips, R.S., Banks, N.J. and Davis, D.T., Jr. (1999). Does the Complications Screening Program flag cases with process of care problems? Using explicit criteria to judge processes. *International Journal for Quality in Health Care* 11(2): 107-18.

Jackson, T., Duckett, S., Shepheard, J. and Baxter, K. (2006). Measurement of adverse events using 'incidence flagged' diagnosis codes. *Journal of Health Services Research and Policy* 11(1): 21-25.

Jackson, T., Michel, J., Roberts, R., Jorm, C. and Wakefield, J. (in press). A Classification of Hospital Acquired Diagnoses for use with routine hospital data. *MJA*.

Jackson, T., Michel, J., Roberts, R., Shepheard, J., Cheng, D., Rust, J. & Perry, C. Development of a Validation Algorithm for 'Condition Onset' Flagging. (Manuscript submitted for publication).

National Centre for Classification in Health (2006). *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM),* Fifth Edition. Sydney, The University of Sydney.

Utah/Missouri Patient Safety Consortium 2002. *Report on the findings of rating the Utah/Missouri ICD-9-CM Adverse Event Code*. Available at: http://health.utah.gov/psi/pubs/Expertpanel.pdf (accessed Dec 2008).

Weingart, S.N., Iezzoni, L.I., Davis, R.B., Palmer, R.H., Cahalane, M., Hamel, M.B., Mukamal, K., Phillips, R.S., Davies, D.T.J. and Banks, N.J. (2000). Use of administrative data to find substandard care: validation of the complications screening program. *Medical Care* 38(8): 796-806.

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