

# Monitoring Sentinel Events Using Routine Inpatient Data

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## Abstract

**Objective:** To explore the extent to which routine inpatient diagnosis data correspond to the Australian nationally-mandated Sentinel Events (SE) data collection and Victoria's additional serious reportable events.

**Background:** Since 2005, state health authorities across Australia have required public hospitals to report on any instance of the eight nationally-agreed 'sentinel events'. The adoption of this list for national monitoring of 'events in which death or serious harm to a patient has occurred' was sponsored by the former Australian Council for Safety and Quality in Health Care. The State of Victoria has policies that support high quality coding of diagnoses in routine hospital data, but it is unclear whether this data source could be used by hospitals to validate voluntary reports and inform ongoing quality improvement efforts.

**Methods:** Code lists were developed by two Health Information Managers to identify ICD-10-AM codes that could be used to define each of the eight national indicators, and an additional 14 subcategories of 'other catastrophic events' reported only in Victoria in 2005. These were translated into computerised algorithms to select cases from the Victorian Admitted Episodes Database (VAED) or 2005/06 which matched the code sets for each of the 22 indicators. We used the 'C-prefix' (now incorporated into the national 'condition onset' flag) in Victorian data to identify hospital-acquired diagnoses, combining these with information on separation mode (specifically, death in hospital), and on admission type (maternity cases) to define some indicators.

**Results:** Seven indicators (one national and seven of the Victoria-specific SEs) could not be replicated using

data available in the VAED, and several others could be replicated only partially. 'Serious harm' could not be identified other than by limiting analysis to deaths associated with (but not necessarily caused by) a SE. Coded records apparently under-reported cases of wrong patient/wrong surgery, suicide by an inpatient and maternal deaths, when compared with voluntary reports. Routine data, however, identified more incidents of retained instruments, gas embolism and medication errors.

**Discussion and Conclusions:** While Australian clinical coding standards are among the best in the world, routine patient abstract data may not be reliable for identifying all types of SEs. Voluntary reporting of adverse events is vulnerable to a different set of human and organisational factors that also impede full reporting. The code sets reported here identify some 'events' that may be less serious than those hospital staff are encouraged to report. This has the advantage of identifying 'near miss' events, but some may be false positives and would not warrant full root cause analysis. Hospital leadership may value the timeliness and low cost of using the routine data and this suggests its use as a second source of information on serious patient safety breaches.

**Abbreviations:** QAHCS – Quality in Australian Health Care Study; RCA – Root Cause Analysis; SE – Sentinel Events; US – United States; VAED – Victorian Admitted Episodes Database; VSE – Victorian Sentinel Events.

**Key Words:** sentinel events, patient safety, adverse events, administrative data.

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## Introduction

Health systems around the world wrestle with improving hospital performance on key patient safety issues. Collecting and publishing incident and adverse event information is a key strategy used in improving patient safety. The purpose of this paper is to investigate the role of routinely-coded hospital discharge data to assist in this effort. One way of using information on compromised patient safety is to require that incidents be internally investigated and their root causes reported. One such reporting system is that of the United States (US) Joint Commission. [1] Building on the US work, the Department of Human Services (now Department of Health) in Victoria introduced a clinical risk management strategy in 2001 and was the first jurisdiction to include a similar collection of Sentinel Events (SEs) for its public hospital system. [2] In 2005, all Australian states agreed to a common collection, with the first national report published in 2007. [3]

The Joint Commission defines a SE as 'An unexpected occurrence involving death or serious physical or psychological injury, or the risk thereof . . . Such events are called 'sentinel' because they signal the need for immediate investigation and response.' [4] Australian authorities use a quite similar definition ('Events in which death or serious harm to a patient has occurred'). [5] Reports to both systems result in a mandated 'Root Cause Analysis' (RCA). RCAs are 'a systematic process whereby the factors that contributed to an incident are identified'. [6] They are designed to assist the hospital involved to learn from the incident, and publication of summary causal factors is intended to help reduce risks in the system as a whole and contribute to system learning.

The collection relies on voluntary reporting of safety breaches by healthcare workers. This has a number of

advantages: it engages the altruism of clinicians to improve patient outcomes, and evidences 'Collaboration between the government, health services, clinicians and consumers striving to continually improve care delivery for patients.' [7]

But voluntary reporting also has a number of drawbacks, particularly for monitoring events at the hospital level, and the system as a whole. Workers involved in such events may feel reluctant to report because of the associated stigma, [8-11] resulting in under-reporting. [12] Perversely, safety-aware health workers and hospitals appear to perform worse than individuals and hospitals that choose not to report to the system. More subtly, by focusing on single, relatively rare events, such reporting may skew system attention toward dramatic and single-cause events, and away from the more mundane and multi-causal. [13]

A second approach to data collection is exemplified by the Quality in Australian Health Care Study (QAHCS). [14] This landmark study used multi-reviewer auditing of medical records to identify adverse (including 'sentinel') events in hospital care, and became a catalyst for much of the recent interest in patient safety. While the methods of the QAHCS study have strong validity for identifying adverse events, the cost and time delay entailed in the review process makes it impractical for routine monitoring of hospital performance.

Australia has a well-supported system of abstracting patient information from the hospital record. Trained medical record coders (along with varying proportions of qualified health information managers) assign ICD-10-AM codes by reviewing each record on discharge. Coders have access to clinicians who treated the patient and to 3 or 4-year university qualified health information managers for advice where notes are ambiguous or difficult to interpret. A number of states use these data as the basis for hospital payment, and Victoria has instituted an independent data audit. The current study thus set out to compare rates of voluntary reporting of SEs with identification of these from the routinely-reported hospital data in Victoria to evaluate the strengths and weaknesses of the two data systems.

## Methods

The eight Australian national SE categories were 'translated' into sets of diagnosis codes in ICD-10-AM. [15] The State of Victoria has supplemented the national list with 14 additional 'Other catastrophic event' categories to broaden the scope of the collection and resulting RCAs. These were also translated into ICD-10-AM codes and are denoted here as Victorian Sentinel Events (VSEs). All event types are shown in Table 1. A health information manager on the

**Table 1: Australian national sentinel event categories and Victorian additions**

SE 1	Procedures involving the wrong patient or body part
SE 2	Suicide in an inpatient unit
SE 3	Retained instruments or other material after surgery requiring re-operation* or further surgical procedure
SE 4	Intravascular gas embolism resulting in death* or neurological damage*
SE 5	Haemolytic blood transfusion reaction* resulting from ABO incompatibility
SE 6	Medication error leading to the death of patient* reasonably believed* to be due to incorrect administration of drugs
SE 7	Maternal death associated with labour or delivery
SE 8	Infant discharged to the wrong family
VSE 9.1	Complications of emergency management (resuscitation)*
VSE 9.2	Complications of anaesthetic management
VSE 9.3	Complication of surgical management
VSE 9.4	Foetal complication of delivery
VSE 9.5	Complication of inpatient fall (associated with death)
VSE 9.6	Complication of inpatient fall (injury not death)
VSE 9.7	Patient absconding from inpatient unit with adverse outcome*
VSE 9.8	Infection control breach*
VSE 9.9	Hospital process issue*
VSE 9.10	Medication error (not resulting in death)
VSE 9.11	Misdiagnosis and subsequent management*
VSE 9.12	Communication of test results*
VSE 9.13	Other - mental health management
VSE 9.14	Other – unspecified*

\*Concepts not able to be fully captured in analysis of routine hospital data

team (CM) nominated code sets for each of the event types. These were independently reviewed by a second health information manager (JS) and a patient safety researcher (TJ), with revisions agreed amongst the reviewers. These revised code sets were then reviewed by the Director of the Victorian Department of Health Statewide Quality Branch (AMCM), and a second round of revisions agreed.

Some event categories required information about whether the patient died in hospital or whether the patient was a surgical or maternity patient; both variables derived from non-diagnosis fields on the patient extract. The full set of

these codes is available from the authors. Limitations in using the morbidity data to replicate definitions that attribute causation; that create overlapping categories; that require linkage of more than one episode; and/or that include particular types of consequent morbidity are considered later in the Discussion.

Data for analysis was the Victorian Admitted Episodes Database (VAED) [16] comprising all public and private separations for the State of Victoria from 1 July 2005 to 30 June 2006 ( $n=2,031,666$ ). Up to 40 fields are available to record clinical details of an inpatient episode. Diagnosis

data are recorded by trained professional coders or health information managers. Data are routinely edited by the Victorian Department of Health, against published standards for plausible code combinations, and the Department conducts audits of patient records from every public hospital, with financial penalties for hospitals with exceptional rates of coding error. [17]

Coding standards require that all diagnoses recorded in the data abstract be documented as actively evaluated or treated during the admission, and/or extended the patient's length of stay. [15] The routine data in Victoria has included information on the timing of diagnoses since at least 1980. [18] For application of the 'C' prefix (indicating a 'complication') the coder must ascertain that there was no evidence of the condition existing prior to admission – that is, the C-prefix is used only for a diagnosis arising after admission. This distinguishes incident diagnoses (arising as a consequence of SEs) from those treated in a subsequent episode. [19] Analysis was undertaken on C-prefixed diagnoses to avoid double-counting arising from readmissions to hospital.

Comparison totals for Australia (using 2004/05 data) and for the State of Victoria (using 2005/06 data) were available from published reports. [3,20] These collections are anonymous (both patient and clinician) and thus could not be linked to the routine data for comparison.

## Results

Overall, the routine data identified more of some event categories, but fewer of others. They flagged significantly more cases of the Victoria-specific events than did voluntary reporting. Useable ICD-10-AM codes could not be found for one of the national SE categories and for six of the Victoria-specific *Other Catastrophic Events* shown in Table 1. *Infant discharged to the wrong family* (SE 8) has no coded equivalent, and has never been reported in either the Victorian or the national data collections. Although the Victorian category *Complication of emergency resuscitation management* (VSE 9.1) could be identified with the diagnosis codes T88.4 *Failed or difficult intubation*, and similar codes in the obstetrics chapter (for intubation problems during pregnancy, labour, delivery and the puerperium), it was judged impossible to distinguish emergency from other intubation using the routine data, leading to the exclusion of this event from the analysis. The Victorian events *Patient absconding from inpatient unit with adverse outcome* (VSE 9.7), *Hospital process issue* (VSE 9.9), *Misdiagnosis and subsequent management*

(VSE 9.11), *Communication of test results* (VSE 9.12), and *Other - unspecified* (VSE 9.14) do not have ICD-10 equivalents and are not further considered here.

The codes available for identifying wrong patient/wrong operation/wrong site cases were only tangentially related to the concept of the sentinel event collection. With the exception of Y65.5 *Performance of inappropriate operation*, there was probably little overlap between the cases identified by the two methods. Variations from the definitions used for other SEs are considered in the Discussion.

Table 2 presents comparative counts for the national SE categories that could be identified using diagnosis coding, with Victorian totals for the same year, and national totals for the preceding year. Victorian coded records showed half the number of cases of *Wrong patient/wrong surgery* (SE 1; 13 vs 25), and *Inpatient suicide* (SE 2; 3 vs 7). Two separate definitions of *Maternal deaths* (SE 6) were trialled, but no cases were found in computerised records, compared with two in the year identified by the voluntary reporting system. This may be attributable to coding standards that discouraged C-prefixing of obstetric diagnosis codes at the time of the study, limiting our ability to identify obstetrics-related SEs.

The routine data, however, identified nearly ten times the number of incidents of *Medication errors* associated with death (SE 5; 20 vs 2) and *Retained instruments or other surgical materials* (SE 3; 53 vs 6). Six deaths associated with *Intravascular gas embolism* (SE 4) were identifiable through the routine data, where none was voluntarily reported. No transfusion reactions were reported in either system; the rarity of this event reflected in the fact that the national collection identified only one in the preceding year. In total, the data algorithm identified 95 national SEs, compared with 42 voluntarily reported to the VSEs collection.

Results for the Victoria-specific 'Other Catastrophic events' are shown in Table 3. These events were subject to larger disparities between the two data sources, with the routine data again identifying more events (4,280 compared with 33 voluntary reports). Over 2,800 injuries were identified in the routine data as attributable to *Inpatient falls* (VSE 9.6), while voluntary reporting resulted in only one such case being identified. Nearly 400 non-fatal *Medication errors* appeared in the routine data compared with only seven voluntary reports.

**Table 2: Frequency of national SE types: coded data vs voluntary reports**

	VOLUNTARY SE REPORTING		
	THIS STUDY 05/06	VICTORIA 05/06	NATIONAL 04/05
SE1 Wrong patient or body part	13	25	53
SE2 Suicide in an inpatient unit	3	7	25
SE3 Retained instruments /material	53	6	27
SE4 Intravascular gas embolism	6	0	1
SE5 Transfusion reaction	0	0	1
SE6 Medication error	20	2	7
SE7(1) Maternal death (O95, O96, O97)	0	2	16
SE7(2) Any maternal death	0	–	–
<b>Total</b>	<b>95</b>	<b>42</b>	<b>130</b>

**Table 3: Victoria-specific Sentinel Events (VSEs)**

	THIS STUDY 05/06	VICTORIA 05/06
VSE 9.2 Complications of anaesthetic management	39*	0
VSE 9.3 Complication of surgical management	543*	5
VSE 9.4 Foetal complication of delivery	9*	2
VSE 9.5 Complication of inpatient fall <sup>§</sup>	309*	4
VSE 9.6 Complication of inpatient fall (other injury)	2837	1
VSE 9.8 Infection control breach	4	3
VSE 9.10 Medication error (not resulting in death)	397	7
VSE 9.13 Other - mental health management	142*	3
<b>Total</b>	<b>4,280</b>	<b>33</b>

\* measured in this study as a complication associated with (not 'causing') death in hospital  
 § defined as 'death or serious morbidity'

The problem of causation is apparent in VSEs 9.2-9.5, and VSE 9.13 where the routine data algorithm uses in-hospital death as the marker of harm. This may overestimate the consequences of the SE (where death resulted from the patient's underlying condition and the complication was a minor one), in contrast to the more nuanced judgments, which can be made in the voluntary reports.

### Discussion

Our findings show that the routine data are capable of identifying a range of serious adverse events in hospital care,

but it is clear that these data have a number of shortcomings for providing SEs information for public reporting. Codes do not exist for some event categories (eg, *Infant discharged to wrong family, Wrong patient or body part*). The Wrong patient event is interesting in that the three very specific codes available do not match the national definition well. A more general code Y65.8 *Other specified misadventures during surgical and medical care* undoubtedly captured some of the 'wrong patient/wrong body part/wrong operation' cases (n=722), but was judged to be too broad to attribute

to the National SE definition. Further development of the Australian Modification of the ICD-10 classification system to take account of patient safety uses for the data could substantially improve the usefulness of coded hospital data.

Establishing causation is particularly problematic. National SE 6 calls for causal links to be made between a medication error and the patient's death, as well as a 'reasonable belief' that 'incorrect administration' was the source of the error. We used death in hospital to proxy for 'catastrophic' outcomes, but the routine data cannot establish that the death was a direct result of these events. Age and procedure type are among the risk factors for hospital-acquired adverse events. [21] Older patients may also be sicker patients, and sicker patients are more vulnerable to hospital-acquired illness and injury because of more intensive treatments and longer stays. They are also at greater risk of death while in hospital. Thus we support Kable and Gibberd's more general warning that in-hospital death can only be considered to be 'associated with' an adverse event in most forms of patient safety research.

Divergences in definition between the voluntary reporting system and the routine data, such as using 'associated with death in hospital' as a surrogate for 'catastrophic events', may explain the higher rates found, especially for the broader Victoria-specific events. It may be the case, however, that 'near misses' are included in the routine coding. For example, VSE 9.10 *Medication Errors (not resulting in death)*, recorded nearly 400 coded events, where the voluntary reporting system identified only 7. Healthcare professionals may not have seen a need for reporting medication errors that did not result in patient harm, but these 'near misses' may give a better picture of the full range of medication-related risks.

We found some SE categories created the potential for overlap. In writing the algorithm for the routine data, we had to resolve whether drug-related *Complications of anaesthetic management* (VSE 9.2) should be assigned as *Medication errors*, and similarly, whether obstetric deaths related to anaesthetics should be counted as *Maternal deaths*. Here, root cause analysis could have prioritised the factors involved to give the best account of the event. For this study, we assigned all complications of anaesthesia to that SE category, and as noted, there were no recorded maternal deaths.

Some of the descriptors of the events required sequenced information, as in *Retained instruments ...requiring re-operation*. The routine abstracts include information about

all procedures performed, but do not allow for particular procedures to be linked to particular diagnoses. Further, without episode linkage, it is not possible to know whether a re-operation occurred when a patient was transferred to another hospital, or in a subsequent admission to the same hospital.

Finally, some of the national definitions require information on morbidity associated with the event. SE 4 *Intravascular gas embolism* seeks to identify 'neurological damage' as well as in-hospital death caused by this outcome. It may be possible to identify specific ICD-10-AM codes that define 'neurological damage' but as routine records are currently structured, neither causation nor sequencing could be unequivocally linked to the SE.

### Conclusion

The routine hospital data is a vastly under-used resource in Australia, particularly given the high quality of coding. The extensive documentation, support and training for coders in Australia means that definitions can be consistently applied, and periodic data audits strengthen the motivation of coders to be accurate and thorough. Scanning routine data for particular forms of patient harm has a very low marginal cost, and could be applied in a timely way (typically monthly) at the hospital level in support of clinical governance.

It was our hypothesis that coders, being further from the bedside, were more likely to record adverse events in patient care (when evidence of these appears in the medical record), providing a useful way of estimating reporting rates. Routine coding can identify 'near miss' events where the level of harm would not be sufficient to motivate clinicians to make a voluntary report. All of these features make the coded data a valuable tool for health service managers to monitor events recorded in their hospital.

Voluntary reporting also has some clear advantages: it provides an inbuilt feedback loop through RCA that can motivate staff involved and demonstrate system learning from SEs. The small numbers of voluntary reports make it feasible to undertake RCA, where the number of coded events might overload such a system. Our work demonstrates that for most event categories, the routine coding identifies a larger number. Publication of rates from the routine data might have the undesirable effect of discouraging recording and/or abstracting of these into the patient record. Clinicians may feel able to make an anonymous SE report even when recording the same event in the patient's record would be compromising; events that are not recorded cannot be coded. Finally, reports

from the front line of healthcare (eg, RCAs) can capture the complex causal links between events and harms that coded data cannot. Analysing the routine hospital data may be a useful way of exploring trends in unintended outcomes, so that patient safety programs can prioritise their efforts to minimise harm.

Given the history of ascribing individual blame for untoward patient outcomes, any data on a healthcare system's performance on safety and quality measures will be controversial. In July 2007, Australia's first national report on SEs in hospital care [3] was greeted with the headline 'Hospital bungles are killing scores'. [22] Routine data can help answer important questions in the healthcare system, and provide a useful way of monitoring the extent to which voluntary reports of SEs are representative of the range of patient harms. Increased use of these data at the facility level would both improve patient safety and the quality of the data itself.

### Acknowledgements

The authors are grateful to the Victorian Department of Health (formerly Human Services) for access to the Victorian Admitted Episodes Database, and to participants in the National Centre for Classification in Health (NCCH) 2007 'Coding Matters' conference for comments on an earlier draft of the paper. The Australian National Health and Medical Research Council provided support for Dr Jackson's participation. All views expressed are those of the authors, and do not represent the policy of the Victorian Department of Health.

### Conflict of Interest

The authors declare that they have no conflicts of interest in this research. The algorithm to identify sentinel events reported here is not copyright and will be available from the authors.

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