ORIGINAL ARTICLE

Detecting and reducing adverse events in an Australian rural base hospital emergency department using medical record screening and review

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Objective: To determine if retrospective medical record screening and clinical review followed by appropriate action can effectively and efficiently detect and reduce adverse events in an emergency department.

Method and participants: The medical records of 20 050 patients who attended the emergency department over a two year period were screened for adverse events using five general patient outcome criteria. Records that screened positive were reviewed by the hospital's clinical risk manager. If an adverse event was detected, the record was also reviewed by the director of emergency. For the first three months details of adverse events were recorded to determine a baseline adverse event rate, but no further action was taken. When an adverse event was found in the remaining 21 months, further analysis and recommendations for action to prevent a recurrence were made to relevant hospital staff.

Setting: A rural base hospital in the Wimmera region of Victoria, Australia between October 1997 and September 1999.

Results: Of all the patient attendances 573 (2.85%) were screened positive for one or more criteria. An adverse event was confirmed in 250 patient attendances (1.24% of all attendances). Of the adverse occurrences, 81 (32.4%) were determined to be of major severity and 169 (67.6%) of minor severity. Quality improvement activities, mostly changes to hospital policies and work processes, were implemented with the aim of preventing the recurrence of specific adverse patient events. Over two years the number of adverse events fell from 84 (3.26% of all patient attendances) in the pre-intervention quarter to 12 (0.48% of all patient attendances) in the final quarter (relative risk reduction 85.3% (95% CI, 62.7% to 100%)).

Conclusions: Adverse events in emergency departments can be efficiently detected and their rate reduced using retrospective medical record screening together with clinical review, analysis and action to prevent recurrences.

Many preventable adverse events occur in hospitals.[1 2] These studies have concentrated on detecting adverse events in inpatient medical records. Comparable studies using emergency department medical records have not been identified. A literature review to determine the extent of adverse events in Australian emergency departments was unable to find studies where emergency department patient records were routinely screened as part of a hospital wide medical record screening and review programme.

However, it has been recognised that adverse events do occur in emergency departments and some qualitative analysis has been undertaken. Factors associated with errors in clinical decision making in emergency medicine include:

1 Patient case load is undifferentiated

2 Assessment time is limited

3 Limited available information about the patient's previous medical history

4 Errors often only detected after patient transfer or discharge[3]

Most adverse events associated with attendances at emergency departments occur as a result of poor clinical management, failure to admit to hospital and errors in medication and triage.[3] A study undertaken at Westmead Hospital, Sydney [4] refers to these factors and also suggests that contact time with patients in emergency departments is too short to monitor progress and decisions are often made without the results of investigations being known. In addition the necessity to attend to several patients simultaneously and often inadequate supervision of junior medical and nursing staff are also important issues. A review of 1800 emergency medicine malpractice cases in Dallas, Texas [5] supports these observations and suggests that some incidents are unique to emergency departments because of the environment in which care is provided and the increased likelihood of adverse events occurring due to diagnostic errors and non-invasive treatments.

Studies using inpatient medical record review to detect adverse events have devised a two step method of screening and clinical review of medical records.[6 7] Detecting adverse events in this manner and taking action to prevent their recurrence has been associated with a reduction in the rate of adverse events.[6] Can this methodology be modified to detect adverse events in an emergency department and then reduce their rate?

METHOD

This study was undertaken at Wimmera Base Hospital in Horsham, 300 km north west of Melbourne. Junior hospital medical officers supported by obstetric, medical and surgical registrars, staff the emergency department. General practitioners and specialists are also available for consultation. The department has over 9000 attendances a year.

A before and after interventional design was used to determine if medical record screening and review could detect and reduce adverse events occurring in emergency department attendances. The Victorian Emergency Minimum dataset and

Table 1 General patient outcome criteria used for screening process

1	Death
2	Unplanned representation to department within 48 hours for same condition
3	Length of stay greater than six hours
4	Transfer to a another acute care facility
5	Presentation to department for same condition within 28 days of hospital inpatient discharge

Table 2 Adverse event clinical causation scale

1 =	little or no evidence
2 =	slight evidence
3 =	not likely (less than 50:50 odds but a close call)
4 =	more likely than not (greater than 50:50 odds but a close call)
5 =	strong evidence
6 =	virtually certain

the Victorian Inpatient Minimum dataset contain patient demographic, diagnosis, procedural and other details as prescribed by the Victorian Department of Human Services (1CD-10-AM) [8] for each patient who is admitted to the hospital or who attends the hospital's emergency department. These datasets were screened to identify those emergency department attendances between October 1997 and September 1999 that met one or more of five general patient outcome criteria (table 1) using a computer program written for the study. The screening criteria were modified from those used to screen inpatient medical records and were also chosen because of their suitability for screening by computer.

The emergency department medical records of patient attendances that met one or more criteria were reviewed by the hospital's clinical risk manager, a senior nurse with 20 years experience in clinical care, who determined if an adverse event was present. An adverse event was defined as "an untoward patient event which under optimal conditions, is not a natural consequence of the patient's disease or treatment".[6] Clinical care was evaluated using a six point scale,[7] to assist in determining whether an adverse event was caused by clinical management (table 2). A score of four or more on this scale was regarded as an adverse event. The severity of the adverse occurrence was then graded using a seven point scale [7] (table 3).

Medical records found by the clinical risk manager to contain an adverse event were then reviewed by the director of accident and emergency. An adverse event analysis form was completed and data entered into a Microsoft Access (Version 7.0) database developed for the study.[9]

Exclusion criteria

Patients who presented to the department within 28 days of inpatient hospital discharge, with the same or similar symptoms, who were then readmitted to the hospital were excluded from the study. These admissions were reviewed in the inpatient adverse event programme described previously.[6]

Data

No medical records of patients attending the emergency department during the study that met one or more of the screening criteria were lost to the study.

Before and after interventional stages

For the first three months of the study the clinical details of adverse events found were recorded as outlined above. No further action was taken, allowing a baseline adverse event rate to be determined. For the remainder of the study, adverse events were also reported and action taken aimed at preventing a recurrence.

Reporting

The clinical risk manager prepared weekly adverse event reports for the emergency department nurse unit manager and the director of medical services. For each adverse event the report gave details of the type of the event, its severity and preventability, the severity of the adverse event and the action already implemented to prevent a recurrence, and any further actions required.

An aggregated quarterly report detailing actions taken and adverse event rates was presented to the hospital's main quality improvement committee, a subcommittee of the board of management.

Actions

Adverse events were analysed by the clinical risk manager and actions were taken aimed at preventing the events from recurring. Most actions were taken after agreement between the director of accident and emergency, the emergency department nurse unit manager and the clinical risk manager. Adverse events that substantially impacted on the hospital were discussed by a surveillance committee consisting of medical and nursing staff representatives and the director of accident and emergency. The committee made recommendations for action that were sent to the medical staff group, consisting of all visiting medical staff for review and following acceptance were implemented. Both nursing and medical staff were actively engaged in the implementation of actions.

Clinical incident reporting

In addition to screening the medical records of all patient attendances, emergency department staff were encouraged to report any clinical incident that occurred in the department. A clinical incident was defined as "any event that has caused harm, or has the potential to harm a patient, visitor or staff member, or any event which involves malfunction, damage or

Table 3 Adverse event severity scale

0 =	minor severity (no disability, no significant resultant discomfort: no cosmetic or functional impairment: and no increased length of stay as a result of adverse event)
1 =	minor temporary (minimal to moderate clinical effect requiring no or minimal clinical intervention, or no increased length of stay or re-hospitalisation for same or related problem)
2 =	minor permanent (minimal to moderate clinical effect with permanent residual, and without significant functional or cosmetic impairment)
3 =	major temporary (moderate to severe clinical effect with no significant functional or cosmetic residual effect). This usually results in increased length of stay or re-hospitalisation and requires moderate to major clinical intervention.
4 =	major permanent (moderate to severe clinical effect with significant functional or cosmetic residual).
5 =	potential major or major contributing (when doubt exists as to the outcome but the probability is that a major impairment or repeated hospitalisation will be necessary). The outcome may result in major impairment.
6 =	Death

Table 4 Records screened positive and adverse events (AEs) for each criterion

Criterion	Number of records screened positive (%)* (n=573)	Number of AEs (%)† (n=250)	AE yield (95% CI)
Unplanned re-presentation within 48 hours of discharge from the emergency department	261 (45.5)	142 (56.8)	54.4% (48.4 to 60.5)
Unplanned presentation within 28 days of discharge from hospital	139 (24.3)	83 (33.2)	59.7% (51.6 to 67.9)
Length of stay >6 hours	89 (15.5)	10 (4.0)	11.2% (4.7 to 17.8)
Transfer to another acute care facility	76 (13.3)	12 (4.8)	15.8% (7.6 to 24.0)
Death	8 (1.4)	3 (1.2)	37.5% (8.5 to 75.5)

*22 (4.11%) records were screened positive for more than one criteria. †25 (10.4%) adverse events were detected by more than one criterion (for example, the same patient may have re-presented to the emergency department within 48 hours more than once).

loss of equipment or property, and for any event which might lead to complaint."[10] Incidents were documented using the Australian Patient Safety Foundation's incident report form and reviewed by the clinical risk manager.

Evaluation of screening process

To determine the effectiveness of the screening and review programme in detecting adverse events in the emergency department, the medical record of each patient attendance over one week was reviewed by a senior emergency department nurse and the clinical risk manager. They determined if the attendance screened positive for one of the five screening criteria and if the attendance was associated with an adverse event.

Review time

The time taken by the clinical risk manager to review emergency department records was recorded weekly. The director of accident and emergency estimated the amount of time he spent on review. The clinical risk manager also estimated the time spent in coordination and liaison with emergency department staff.

Statistical analysis

The χ^2 test was used for categorical comparisons of data. A p value of <0.05 was considered to indicate statistical significance; all tests were two tailed. Statistical analyses were performed on a personal computer with the statistical package GraphPad Instat.[11] Confidence intervals were calculated using standard methods.[12]

Statutory immunity

The project was conducted under the statutory immunity of the hospital's quality improvement committee in accordance with Section 139 of the Health Services Act 1988.

RESULTS

There were 20 050 patient attendances in the emergency department between October 1997 and September 1999. Using the five general patient outcome criteria, 573 emergency department medical records (2.85%) were screened positive for one or more criteria. The commonest criterion that screened positive was unplanned re-presentation within 48 hours of discharge from the emergency department (45.5% of all attendances that screened positive) and unplanned presentation to the emergency department within 28 days of hospital discharge (24.3% of all attendances that screened positive).

The most efficient criterion for detecting adverse events were "unplanned re-presentation within 28 days of discharge from hospital" in which 59.8% of attendances that screened positive for this criterion contained an adverse event and "unplanned presentation within 48 hours of discharge from the emergency department" in which 54.4% of attendances that screened positive for this criterion contained an adverse event. The least efficient criterion was "length of stay greater than 6 hours" in which 11.2% of emergency department attendances that screened positive for the criterion contained an adverse event. Overall 90% of the adverse events detected in the study were found using the two most efficient criteria (table 4).

After medical review, 250 records (1.2% of all patient attendances) were found to contain an adverse event using the six point scale. Of these 250 occurrences, 81 were major (32.4%) and 169 were minor (67.6%). Also, 156 (62.4%) were assessed as potentially preventable, 90 (36.0%) as preventable and 4 (1.6%) as not preventable.

Examples of the types adverse events detected included

- A 48 year old man presented with abdominal pain, vomiting and an increased white cell count. He was discharged home without surgical review and re-presented requiring admission with cholecystitis.
- A 22 year old man presented with a suspected fractured mandible. There is a 6.5 hour delay in obtaining radiographs and a surgical review.
- A 62 year old woman presented with a forearm fracture and a plaster was applied. The patient was not reviewed by a senior doctor and re-presented with pain and poor alignment requiring reapplication of the plaster.
- A 69 year old woman presented with severe abdominal pain. A diagnosis was made of a urinary tract infection and the patient was discharged home. She re-presented the following day with continuing pain requiring emergency surgery.
- A 4 year old was brought to the department with a painful leg following trauma and was unable to weight bear. A radiograph was not taken and the patient was discharged. A subsequent radiograph revealed a greenstick fracture.

Reviewers described the types and number of errors associated with each adverse event. Some adverse events involved more than one error. A total of 323 errors were associated with the 250 adverse events detected. The commonest errors were avoidable delays in diagnosis 49 (19.6%), inadequate functioning of a hospital service 49 (19.6%), inadequate reporting or communication 40 (16.0%), technical error 26 (10.4%), practising outside area of expertise 25 (10.0%) and avoidable delay in treatment 20 (8.0%).

The emergency department records of patients older than 60 years were more frequently found to contain an adverse event (AE) compared with the records of patients less than 60 years of age (AE rate of 1.81% *v* 1.11%, $\chi^2 = 12.63$, df = 2, p=0.0018; χ^2 TR =7.96, df=1, p=0.0048). The adverse event rate was similar for male and female patients (table 5).

The commonest major diagnostic categories associated with adverse occurrences were digestive (18.4% of all adverse events detected), musculoskeletal (14.0%) and genitourinary disorders (10.4%) (table 6).

Actions

When adverse events were detected, actions aimed at preventing recurrences were undertaken. These actions included:

Table 5 Number of adverse events (AEs) detected by sex and age

Characteristics	Number AEs (%) (n=250)	Number patient attendances (n=20050)	AE rate (% of patient attendances)	Odds ratio (95% CI)
Sex*				
Male	127 (50.8)	10712 (53.4)	1.18	1.00
Female	123 (49.2)	9338 (46.6)	1.31	1.11 (0.87 to 1.43)
Age (y)†				
0–30	107 (42.8)	9546 (47.6)	1.12	1.03(1.01 to 1.05)
31–60	71 (28.4)	6515 (32.4)	1.09	1.00
61+	72 (28.8)	3989 (20.0)	1.81	1.66 (1.26 to 2.19)

*χ^2=0.60; df=1; p=0.44. †χ^2=12.63; df=2; p=0.0018. χ^2TR=7.96; df=1; p=0.0048.

Table 6 Adverse events (AEs) in each major diagnostic category

Diagnostic category	Number of AEs (%) (n=250)
Digestive disorders	46 (18.4)
Musculoskeletal	35 (14.0)
Genitourinary disorders	26 (10.4)
Mental disorders	22 (8.8)
Circulatory disorders	23 (9.2)
Respiratory	21 (8.4)
Injury and poisoning	20 (8.0)
Nervous and sensory disorders	15 (6.0)
Infection and parasitic disorders	14 (5.6)
Ill defined conditions	11 (4.4)
Pregnancy, birth, puerperium	10 (4.0)
Endocrine	4 (1.6)
Skin disorders	3 (1.2)

changes in relevant hospital policies, focused auditing, discussion with staff involved in particular adverse events and implementation of clinical guidelines.

Changes made in hospital policies were of both a clinical and administrative nature. Focused audits were undertaken on the type and number of radiology requests, radiology waiting times and the follow up of patients with fractures or eye injuries. Organisational systems were analysed to identify factors that contributed to the occurrence of particular adverse events and these analyses resulted in the following changes:

- A copy of the emergency department medical record for each patient attendance not requiring hospital admission is sent to the patient's general practitioner.
- Copies of all pathology and radiology reports for investigations initiated in the emergency department are now sent to both the emergency department doctor ordering the investigation and the patient's general practitioner.
- During the second year of the study a senior hospital medical officer was appointed to the emergency department.
- A senior hospital medical officer reviews all patients re-presenting to the department within 48 hours with the same or similar symptoms before discharge or admission.
- Patients requiring ongoing management of fractures or eye injuries are referred back to their general practitioner.
- A regional crisis assessment team provides triage services and advice on the management of psychiatric patients presenting to the emergency department.
- Patients presenting with chest pain are triaged as category two (treatment time within 10 minutes).
- Guidelines with adhesive backing are used to improve documentation and detail the reason for tetanus immunisation.

To determine the effect of these actions on the rate of adverse events, events detected during the study were divided into those that occurred in the quarter prior to any intervention and in each quarter during the intervention period.

Table 7 Adverse event (AE) rate per quarter

Quarter ending	Number of AEs	Number of patient attendances (n=250)	AE rate (% of patient attendances) (n=20050)
December 1997*	84	2575	3.26
March 1998	38	2371	1.60
June 1998	37	2461	1.50
September 1998	20	2392	0.83
December 1998	26	2664	0.97
March 1999	16	2720	0.58
June 1999	17	2373	0.71
September 1999	12	2494	0.48

*Pre-intervention period. χ^2=120.43; df=7; p<0.0001. χ^2_{TR}=87.64; df=1; p<0.0001.

The number of patient attendances associated with an adverse event fell from 84 (3.26% of all patient attendances) in the pre intervention quarter to 12 (0.48% of all patient attendances) in the final quarter (relative risk reduction 85.3% (95% confidence intervals 62.7% to 100%)) (χ^2 =120.43, df=7; p=<0.0001) and the trend was linear (χ^2_{TR} = 87.64; df =1; p=<0.0001) (table 7).

Clinical incident reporting

During the study, five clinical incidents relating to patient attendances in the emergency department were reported via the hospital's clinical incident reporting system. There was no overlap between the adverse events detected by screening emergency department records and those detected by the reporting of clinical incidents by staff.

Evaluation of screening process

To evaluate the effectiveness of the screening process in detecting patient attendances that met one or more criteria, the emergency department medical records of 146 consecutive patient attendances over one week were reviewed independently by a senior emergency department nurse and the clinical risk manager. This manual screening programme identified 20 medical records that met one or more of the screening criteria. These 20 attendances had all been screened positive by the computer screening programme. No additional attendances were found by manual screening to contain criteria that had not been previously identified by computer screening.

Each of the 146 medical records were also reviewed to determine how many contained an adverse event. Three medical records initially screened as negative by the five screening criteria were found to contain an adverse event.

Of these three records, one was not screened positive by the computer program because of incomplete data entry, one patient re-presented five days after initial treatment, which was beyond the 48 hour screening criterion and one

attendance was the result of an error made by a community service provider outside the hospital. These three adverse events were of minor severity.

Resources

All records were screened and reviewed within seven days of patient discharge from the department. The mean time for record review was one minute. Approximately one hour per week was required to undertake screening, review and reporting.

DISCUSSION

Adverse events occurring in emergency departments can be detected by screening and reviewing medical records. The rate of adverse events can be reduced by analysing these events, taking appropriate action and monitoring the effectiveness of these actions. This reduction in adverse events can be achieved at reasonable cost.

Larger inpatient studies have determined adverse event rates at one period in time, whereas this study measured adverse event rates before and after interventions aimed at reducing their frequency. This study was conducted in a regional rural city with a small and stable medical environment. If an adverse event with significant consequences occurred in the department and was not detected by medical record review, the patient would probably return to the department or consult a general practitioner with an appointment at the hospital. This should increase the likelihood of the event being discovered. In larger populations follow up medical care after emergency department attendance at a particular hospital is often provided by doctors who have no links to that hospital. This increases the chance that some adverse events associated with emergency department attendance may not be brought to the attention of the treating hospital.

The screening process in this study used data routinely collected by most emergency departments in Victoria eliminating the need for additional resources to create new patient databases.

The methodology used in this study did not detect all the adverse events that occurred in the department. Firstly, the details of adverse events are not always recorded in the medical record. Secondly, the five screening criteria used could not be expected to find all the records that contained an adverse event. The study design did not include a control hospital where adverse events were detected but not acted upon. Other factors besides the actions taken aimed at reducing the adverse event rate such as an increased awareness of adverse patient events, changes in staff and changes in policies unrelated to this programme may result in changes in practice and fewer adverse events.

Also medical record reviewers were not blinded to patient and clinical staff identifying details. Additional resources would have been required if each record that screened positive was deindentified and reviewed independently by at least two reviewers as occurred in the larger Harvard Medical Practice Study and Quality in Australian Health Care Study.

Adverse event screening and review has previously been shown to efficiently detect adverse events in inpatient medical records and with appropriate action, reduce the rate of adverse events.[6] This study has demonstrated that the same methodology using modified screening criteria can be adapted to patient attendances in the emergency department. The process is more efficient in finding adverse events in the emergency department as only 2.71% of the department's medical records required medical review compared with 9.2% of inpatient records in a previous study,[6] although this may partly be attributable to five screening criteria being used in this study compared with eight screening criteria in the inpatient study. The reduction in the adverse event rate was greater and achieved more quickly in the emergency department (85% reduction over two years) compared with a 57% reduction over three years in the adverse event rate associated with inpatients.[6]

We were unable to locate comparable studies measuring the rate of adverse events in emergency departments. Emergency departments have relied on voluntary clinical incident reporting, patient complaints or poor patient outcomes to detect adverse events and provide the impetus for managing clinical risk. In this study medical record screening and clinical review identified many adverse events that occurred in the emergency department that were not detected by voluntary incident reporting.

Simple errors by health care professionals were rarely the cause of an adverse event in this study. Adverse events were usually the result of flaws in the complex organisational systems in which the emergency department operates. Significant latent factors included limited supervision of junior medical officers and the lack of constraint on their practice. Critical to overcoming these flaws was a recognition that most systems in health care delivery have weaknesses that can potentially compromise patient safety. In addition blame and punishment of people for adverse events was relatively ineffective in preventing recurrence and should be replaced with a culture of cooperation and continuous improvement.

The programme has the potential to simply and inexpensively detect and reduce adverse events in hospital emergency departments and regularly provide information about the quality of care provided. However, to assess this potential requires the establishment and evaluation of the programme in other hospitals. The culture in individual hospitals varies and is probably a significant factor in the success or otherwise of quality improvement initiatives.

The assessment of whether an adverse event has occurred is subjective. Therefore adverse event rates determined using this methodology could not be used to meaningfully compare rates between hospitals. However, in individual hospitals, if the methodology and reviewers are kept constant, the rate of adverse events detected over time could be meaningfully interpreted.

Further research is required, to determine if the proportion of adverse events detected using record review can be enhanced using different screening criteria. Changing clinical behaviour is a complex and challenging task. Assisting staff to recognise and take ownership of opportunities to improve care is fundamental to changing clinical practice. Many quite different approaches are available.[13] Further analysis is required to determine the causes of adverse events in emergency departments and the actions that are effective or ineffective in reducing the rate of these events.

Achieving improvement in the provision of emergency care will not happen by accident.[14] Improvement must be intended and managed. This requires an understanding of the causes of adverse events and development of actions that tackle system deficiencies. Adverse event screening and review provides a method of continuously monitoring and improving the quality of clinical care in the emergency department.

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