ORIGINAL ARTICLE

Preventable deaths in patients admitted from emergency department

T-C Lu, C-L Tsai, C-C Lee, P C-I Ko, Z-S Yen, A Yuan, S-C Chen, W-J Chen

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See end of article for authors' affiliations

Correspondence to:
Dr Zui-Shen Yen,
Department of Emergency
Medicine, National
Taiwan University
Hospital, No.7, Chung-
Shan South Road, Taipei
100, Taiwan; zuishen@ha.
mc.ntu.edu.tw

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Background: There is limited data about how appropriate medical care is in the emergency department (ED).

Objectives: To investigate the rate and types of preventable deaths among patients with early mortality after emergency admission from the ED.

Methods: We retrospectively reviewed charts of early mortality (defined as mortality which occurred within 24 hours after admission from the ED) over a 3 year period. Those patients with terminal cancer or out of hospital cardiac arrest (OHCA) at presentation were excluded. Two independent assessors reviewed each eligible chart and determined whether early mortality was preventable. Any disagreements were resolved through discussion between the investigators. A mortality event was considered preventable if actions or missed actions were identified that would have prevented the death. The types of preventability were categorised as misdiagnosis, delayed diagnosis, and inappropriate medical management. Interrater reliability in the initial determination was assessed using Cohen κ statistic.

Results: Over a 3 year period, 210 early mortality cases were identified. Excluding patients with terminal cancer or OHCA, the rate of preventable deaths was 25.8% (32/124). The types of preventability were inappropriate medical management (17 patients), delayed diagnosis (eight), and misdiagnosis (seven). There was good agreement between assessors with a Cohen κ statistic of 0.81.

Conclusions: Preventable deaths in emergency admitted patients with early mortality are not uncommon. Analysis and identification of preventability early mortality by using a chart based method may be used as a quality assurance index in emergency medical care.

Medical errors are a major cause of morbidity and mortality worldwide. The Harvard medical practice study found that adverse events occurred in 3.7% of the hospital admission and 27.6% of the adverse events were because of negligence.¹ Seward *et al* also detected potential "faults" in 7% of deaths following emergency admission.² However, there were limited data about how appropriate medical care is in the emergency department (ED). In a busy environment like the ED, where systematic follow up of the clinical outcomes of ED patients admitted to hospital is generally poor, emergency physicians (EPs) may be unaware of adverse outcomes and have no feedback about the errors they made.^{3–4}

The detection of adverse events and preventable deaths through comprehensive chart review in all patients admitted from the ED is a time consuming process, which would be almost impractical in daily emergency medicine practice. To streamline this process, we used a chart based method to detect preventable deaths in patients who died within 24 hours after emergency admission to the ward or the intensive care units (ICU). Although a recent study by Famularo *et al* used a similar method to detect clinical errors in the ED,⁵ they addressed only four selected case reports to highlight the most severe clinical errors.

Some articles have discussed the issue of preventable deaths with focus primarily on major trauma or inpatient systems;^{6–11} however, there is still no systematic approach in the medical literature to monitoring and preventing medical errors in the ED. This study investigated the rate and types of preventable death among patients with early mortality. We also tried to find the feasibility of using preventable death rate as a quality assurance index in emergency medicine.

METHODS

Study design

This was a retrospective observational study. Building upon previous studies using method of medical charts review,^{12–18} we used a chart-based method to identify preventable deaths. The study method was exempt from approval of the institutional review board of our hospital.

Setting

This study was conducted at a university affiliated tertiary medical centre (2400 beds) with more than 110 000 emergency visits annually. Residents training in emergency medicine, internal medicine, surgery, and paediatrics all work in the ED on a rotational basis.

Selection of participants

Early mortality was defined as mortality that occurred within 24 hours at the ward or the ICU after admission to the hospital from the ED. The medical charts of patients that met the criteria of early mortality between July 1999 and June 2002 were first identified by a computer search from the hospital database. To ensure patient confidentiality, all the investigators were required to follow the corresponding regulations of our hospital and keep patients' personal information in confidence. The medical chart was then carefully reviewed by two independent board certificated EP assessors (TCL, CLT) to determine whether an early mortality event was preventable. These two assessors were blind to each other's opinion during initial assessment. Data abstracted from each medical charts included patient age,

Abbreviations: ED, emergency department; EP, emergency physician; ICU, intensive care unit; OHCA, out of hospital cardiac arrest

sex, medical history, physical examination, and laboratory findings, admission and mortality diagnoses, length of ED stay, and length of admission.

Study protocol

We used a three stage process to evaluate all medical charts that met the criteria of early mortality. First, each chart that met the inclusion criteria was identified by a computer search. Patients were excluded from the study if it was documented that they had terminal cancer or out of hospital cardiac arrest (OHCA) at presentation to the ED. In the second stage, we asked the two independent assessors to review each eligible chart and to determine whether an early mortality event was preventable. Several aspects of the diagnostic process and patient management were considered, including patient history, tests ordered, interpretation of clinical data, choice and performance of procedures, injury pattern recognition, reasoning, and evaluation. A mortality event was considered preventable if there were actions or missed actions that would have prevented the death. In the final stage, if the opinions of the two assessors differed, disagreements were resolved through discussion between the investigators. Those mortality events determined as non-preventable were judged as natural course of disease progression—that is, the mortality event was unavoidable by any standard of care means currently available.

Table 1 shows the criteria used to define the types of preventability during the chart review process and the disagreement/resolving committee between investigators for the purpose of this study. Misdiagnosis was defined as mortality diagnosis significantly differing from ED disposition diagnosis in clinical medical care. Delayed diagnosis was defined as a delay in making the correct diagnosis and providing timely medical care with potential contribution to early mortality. Inappropriate medical management was defined as other actions or missed actions that would result in the unexpected death.

Primary data analysis

Descriptive statistics was used to analyse the data set. Interrater reliability in the initial assessment between the two evaluators was analysed with Cohen κ statistic.¹⁹

RESULTS

During the 3 year study period, a total of 178 315 patients were admitted to the hospital and 45 100 were admitted from the ED. Among those who were admitted from the ED, 5560 were admitted to the ICUs and 39 540 were to the general wards. The total emergency visits were 315,890 during the 3 year period. Early mortality was identified in 210 patients. Eighty six patients were excluded from the study because of terminal cancer (37 patients) or OHCA at presentation (49 patients). Among the 124 patients eligible for reviews, 116

Table 2 Characteristics of patients with preventable versus non-preventable deaths (n = 124)

Characteristics	Preventable (n = 32)	Non-preventable (n = 92)
Male, n (%)	15 (46.9)	43 (46.7)
Median age, year	53	56
Time of stay in ED, median in hours	62.4	67.2
Time from admission to death, median in hours	8.5	7.4

patients were admitted to the ICU and eight were admitted to the general ward. The median age of the study cohort was 55 years (range 5 to 88 years), and 58 patients (46.8%) were male. The characteristics of these patients are shown in Table 2.

Based on chart review by two EP assessors, and discussion between investigators, there were 32 patients thought to have preventable deaths. The rate of preventable deaths among the patients with early mortality was 25.8% (32/124). Of the 32 preventable deaths, 24 occurred in patients admitted to the ICU and eight in general wards. A summary of admission diagnosis, mortality diagnosis and types of prevention is shown in Table 3. The types of preventability were inappropriate medical management in 17 patients, delayed diagnosis in eight, and misdiagnosis in seven.

There were nine inconsistencies between the two evaluators initially (Table 4). After full discussion between investigators, four were categorised as preventable and five were categorised as non-preventable deaths. The assessment of interrater reliability in the initial determination of preventable deaths gave Cohen κ statistic of 0.81.

DISCUSSION

Unexpected death after emergency admission to hospital occasionally occurs in daily emergency medical practice. Although most of the early mortality cases were attributable to the natural course of disease progression, we found the rate of preventable deaths (25.8%) was high in this study. The lack of efficient systematic methods to identify those cases of unexpected death may lead to recurrence of these adverse events. We used a chart based review method to identify those preventable aspects associated with unexpected deaths soon after emergency admission to hospital, and tried to draw more attention to the quality improvement of emergency medical care.

Although preventable adverse events may imply medical errors,^{13–20} we would prefer to use the term preventable deaths to denote the unexpected nature of death among these patients in our study. In agreement with the opinions addressed of McDonald *et al* and Hughes,^{21–22} we believe medicine is an ever changing art and that deaths because of wrong judgment may not necessarily indicate errors in some circumstances, although they may be preventable through adequate physician training and feedback monitoring systems.

To improve patient safety and prevent adverse events in emergency medical care, we believe it is necessary to develop working feedback systems and quality assurance indices to assess EP performance. An extensive chart review method has been one of the many strategies used but it is time consuming and may not practical in a busy emergency care setting. Although we could miss events that occur more than 24 hours after admission, and those that occur in patients who are not admitted, our strategy is still an efficient and practical method to identify those cases at higher risk of preventable adverse events.

Table 1 Preventability criteria

Preventable: any identifiable actions or missed actions that would have prevented the death	
Misdiagnosis	Final mortality diagnosis significantly differing from ED disposition diagnosis in clinical medical care
Delayed diagnosis	Delay in making the correct diagnosis and providing timely medical care with potential contribution to early mortality
Inappropriate medical management	Other actions or missed actions that would result in the unexpected death of the patient
Non-preventable: the mortality event was unavoidable by any means of the currently available standard of care.	

Table 3 Admission diagnosis, mortality diagnosis, and type of preventability in patients with preventable early mortality after emergency admission

	Admission diagnosis	Mortality diagnosis	Type of preventability
Patient 1	Acute gastroenteritis	Septic shock	Misdiagnosis
Patient 2	Necrotising fasciitis	Necrotising fasciitis	Delayed diagnosis
Patient 3	AAA with rupture	AAA with rupture	Delayed diagnosis
Patient 4	Pneumonia with septic shock	AMI with cardiogenic shock	Misdiagnosis
Patient 5	Sudden collapsed, cause?	AMI with cardiogenic shock	Delayed diagnosis
Patient 6	Stool impaction	Septic shock	Misdiagnosis
Patient 7	Perforated peptic ulcer	Perforated peptic ulcer	Delayed diagnosis
Patient 8	Shock, cause?	SBP with septic shock	Misdiagnosis
Patient 9	AMI with cardiogenic shock	AAA with rupture	Misdiagnosis
Patient 10	Fever	GNB sepsis	Misdiagnosis
Patient 11	Urosepsis	Urosepsis (pseudomonas)	Inappropriate management
Patient 12	UGI bleeding, Hepatic coma	UGI bleeding, hepatic coma	Inappropriate management
Patient 13	SBP	SBP with septic shock	Inappropriate management
Patient 14	UGI bleeding, suspect OVB	UGI bleeding, suspect OVB	Inappropriate management
Patient 15	Ileus	Septic shock	Inappropriate management
Patient 16	Hypotension	Septic shock	Inappropriate management
Patient 17	Anaemia	Septic shock (<i>E. coli</i>)	Misdiagnosis
Patient 18	Asthma	Status asthmaticus	Inappropriate management
Patient 19	Septic shock	GNB sepsis with DIC, SAH	Inappropriate management
Patient 20	UGI bleeding	AAA with rupture	Inappropriate management
Patient 21	HCC	UGI bleeding	Inappropriate management
Patient 22	CHF	Hyperkalaemia, VT	Delayed diagnosis
Patient 23	Acute myocarditis	Cardiogenic shock	Inappropriate management
Patient 24	Pulmonary tuberculosis	Respiratory failure	Inappropriate management
Patient 25	Haemorrhagic shock	Haemorrhagic shock	Inappropriate management
Patient 26	Oesophageal obstruction	Respiratory failure	Inappropriate management
Patient 27	Sepsis	CNS infection	Delayed diagnosis
Patient 28	Sepsis	Liver abscess	Delayed diagnosis
Patient 29	AMI	AMI	Delayed diagnosis
Patient 30	Sepsis	Septic shock	Inappropriate management
Patient 31	Hypertension	GNB sepsis	Inappropriate management
Patient 32	Pericardial effusion	Pericardial effusion	Inappropriate management

AAA, abdominal aortic aneurysm; AMI, acute myocardial infarction; CHF, congestive heart failure; CNS, central nervous system; DIC, disseminated intravascular coagulopathy; GNB, Gram negative bacilli; HCC, hepatocellular carcinoma; OVB, oesophageal varices bleeding; SAH, subarachnoid haemorrhage; SBP, spontaneous bacterial peritonitis; UGI, upper gastrointestinal tract; VT, ventricular tachycardia.

Although the use of autopsies or necropsies for examination of diagnostic errors is of value during the review process. According to the unpublished national registry data written in Chinese, the forensic autopsy rate is around 9% among all medico legal cases in Taiwan, which is much lower than that of the western country. The lack of sufficient forensic doctors in Taiwan may contribute to the causes of low autopsy rate. The hospital autopsy rate is around 5% in our hospital during recent years according to the hospital registry data. Among them, two thirds of the cases are because of stillbirth. Because of legal issues increasing in our daily medical practices, the physicians are not willing to persuade the family to accept autopsy just to clarify the actual cause of death. Even when doctors think it is necessary to perform an autopsy to determine the presence of any undiagnosed

Table 4 Agreement between two assessors about preventability of early mortality

	Preventable	Non-preventable	Total
Preventable	28	3	31
Non-Preventable	6	87	93
Total	34	90	124

κ coefficient of agreement between assessors was 0.81.

disease, families in Taiwan are likely to “preserve the whole body” and will not accept autopsies because of their folk culture. Furthermore, in the opinions of Kirch and Schaffi,²³ there has been no appreciable change in the spectrum of diseases that prove difficult to diagnosis but rather the atypical course of a common and well known disease that lead to diagnostic errors. Of the 124 patients with early mortality, we found that misdiagnosis or delayed diagnosis (15/32) accounts for the major proportion of preventable deaths. These findings may imply that making a correct diagnosis is the most complex and challenging tasks for EPs.^{24–25} We believe a very important mission for a competent EP is to identify the patients at high risk of mortality and treat them appropriately in a timely manner. Further research should examine whether the identification of preventable deaths can promote patient safety and prevent adverse events in the ED.

Readers may find that the “time of stay in ED” is disproportionately long especially when compared to the subsequent “time from admission to death” in our study. Similar to the United States,²⁶ ED overcrowding is emerging as a serious issue in our hospital.^{27–28} There are often no available beds to admit all the patients who are in need of hospitalisation. Most of the patients need to stay in our ED observatory units to receive treatment prior to their admission to the hospital. This is the reason why we need to evaluate the preventable aspects of ED care in patients who die soon after their admission to hospital from the ED. Although there are no sufficient data in our study to clarify the relation between ED overcrowding and its threat to patient safety, a previous report has shown that such circumstances may result in a delay of diagnosis and treatment.²⁹ A multidisciplinary approach must be carried out to eliminate the problem of ED overcrowding and to elucidate the relation between the effect on decreasing preventable death rate in the ED.

While reviewing the charts, we identified several potentially avoidable factors contributing to preventable deaths:

1. Failure to initiate antibiotic treatment in patients with signs of septic shock.
2. Failure to recognise ruptured abdominal aortic aneurysm.
3. Failure to request or interpret bedside electrocardiography in patients with signs of acute coronary syndrome.
4. Incomplete physical examination leading to delayed diagnosis.
5. Neglect of abnormal laboratory data.

There are several limitations in this study. First, in an attempt to analyse the inappropriate aspects of ED care associated with early mortality after emergency admission, we used restrictive and arbitrary criteria for the selection of cases. Only the charts of patients who died within 24 hours of admission were reviewed. Such a strategy was used to decrease the influence of events that occurred after patient's admission. However, there is no clear threshold as to the best post-admission cut-off point to achieve this objective. Some

preventable deaths may be missed because the deaths occurred more than 24 hours after admission. Second, as we evaluated only patients who were admitted, we may have missed patients who died after discharge from the ED. There are still no efficient methods to identify these preventable deaths. Further research is needed to assess the types and incidence of preventable death among these patient groups. Third, judgments about the appropriateness of care in our study were made retrospectively with full knowledge of the fatal outcome of these cases. Hindsight bias may exist. The use of multiple levels of physician-reviewers and a multi-disciplinary committee consisting of representatives from the fields of physician specialists, nursing staff, hospital administration, and social workers may lower the subjectivity of human judgments and help reduce such potential bias. Fourth, there is lack of autopsy data as a diagnostic gold standard in our study. We tried to identify diagnostic errors through careful chart review to examine the thinking pattern and cognitive errors that can result in diagnostic errors and significantly contribute to the cause of early mortality. Fifth, because all the investigators belong to the same institution, it is difficult for us to be independent from the institution. We conducted this study through chart reviews by two assessors initially and resolved disagreement through discussion between investigators by using preset preventability criteria. We tried to remain objective and independent during the process of chart review and discussion between investigators.

In summary, preventable deaths in patients with early mortality after emergency admission to hospital are not uncommon. Analysis and identification of preventability among early mortality by using a chart based method may be used as a quality assurance index in emergency medical care.

Authors' affiliations

T-C Lu, C-L Tsai, C-C Lee, P C-I Ko, Z-S Yen, A Yuan, S-C Chen, W-J Chen, Department of Emergency Medicine, National Taiwan University Hospital, Taipei, Taiwan

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