Unanticipated Death After Discharge Home From the Emergency Department

David P. Sklar, MD
Cameron S. Crandall, MD
Eric Loeliger, MD
Kathleen Edmunds, MD
Ian Paul, MD
Deborah L. Helitzer, ScD

From the Department of Emergency Medicine (Sklar, Crandall, Loeliger, Edmunds), and Department of Family and Community Medicine (Helitzer), School of Medicine, University of New Mexico; and the Office of the Medical Investigator, State of New Mexico (Paul), Albuquerque, NM.

Study objective: We measured the frequency of unanticipated death among patients discharged from the emergency department (ED) and reviewed these cases for patterns of potential preventable medical error.

Methods: This was a retrospective cohort of ED patients who were discharged to home from an urban tertiary-care facility after their evaluation, with subsequent case review. Subjects were aged 10 years and older, representing 387,334 visits among 186,859 individuals, February 1994 through November 2004. The main outcome was mortality. Deaths were assessed for relatedness to the last ED visit, whether the death was expected, and whether there was possible medical error. Deaths that were unexpected and related to the ED visit were analyzed using grounded theory to identify common themes among these cases. Error cases were identified as a subset of this group.

Results: We identified and reviewed 117 patients, or 30.2 deaths within 7 days of discharge per 100,000 ED discharges home (95% confidence interval [CI] 25.2 to 36.2 deaths). Of the 117 cases, 58 (50%) were unexpected but related to the ED visit and 35 (60%) of these had a possible error. For the unexpected, related group, there were 15.0 deaths within 7 days per 100,000 discharges home (95% CI 11.6 to 19.4 deaths); for the possible error group, there were 9.0 (95% CI 6.5 to 12.6 deaths). Four themes repeatedly emerged: atypical presentation of an unusual problem, chronic disease with decompensation, abnormal vital signs, and mental disability or psychiatric problem or substance abuse that may have made it less likely that the patient would return for worsening symptoms.

Conclusion: Monitoring of death records can identify unanticipated deaths after health care encounters. Further hypothesis-driven research is needed to identify, prevent, or mitigate problems in care and reduce the rate of death after ED visit. [Ann Emerg Med. 2007;49:735-745.]

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INTRODUCTION

Background

Recent attention to medical error as a cause for preventable death has led to increased efforts in quality improvement and identification of medical errors.[1,2] The emergency department (ED) has previously been identified as an area of high risk for medical error leading to death.[3,4] Patients who are treated in an ED, sent home, and subsequently die could be victims of medical errors. Previous research on patients treated in the ED demonstrated that 13 per 100,000 died after ED discharge and 3 per 100,000 had an unexpected death that was directly related to the ED visit.[5] In this previous study, the authors relied on identification of an ED visit within the medical examiner report. Ruptured aortic aneurysm was the most common finding of the unexpected related deaths in this series. The authors also did not attempt to determine whether errors had occurred.

Importance

Prospective data that measure the risk of death after an ED visit are lacking. Such deaths are important as part of a quality improvement process, as well as having importance with

Editor's Capsule Summary

What is already known on this topic

Death of a patient shortly after emergency department (ED) discharge is every emergency physician's fear, but little is known about the frequency of such events or factors that might contribute to them.

What question this study addressed

The frequency of death occurring within 7 days of ED discharge, whether the death was unexpected, and, if so, whether a medical error may have been contributory.

What this study adds to our knowledge

In this review of almost 400,000 patients discharged from an academic medical center during a 10-year period, roughly 30 per 100,000 patients died within 7 days of ED discharge, 20 per 100,000 unexpectedly and 9 per 100,000 with a potentially contributory medical error. Atypical presentations, exacerbation of chronic disease, abnormal vital signs, and substance abuse were common themes.

How this might change clinical practice

These data may inform efforts to decrease medical errors and identify high-risk patients, such as developing better methods for assessing the significance of abnormal vital signs.

regard to medicolegal risk. Existing surveillance systems usually identify cases within their own network and may not identify these extremely important cases because patients may not return to the same ED or health care facility. These cases offer the opportunity to examine care for possible problems in the care provided that may have contributed to the death.

Goals of This Investigation

Our study used probabilistic data linkage to calculate a death rate after discharge and subsequently reviewed cases to determine whether the deaths were expected or unexpected according to their medical history, related or unrelated to the ED visit, and whether a possible error had occurred associated with the death. We used a qualitative data analytic technique called grounded theory to review the case material for unexpected and related cases to identify common themes or groupings from which more specific hypotheses might be generated for the current and future studies.[6]

MATERIALS AND METHODS

Study Design

We used a retrospective cohort design to identify a series of patients who were treated in our ED and who died within 7 days of being discharged to home. After these cases were identified and information was collected, we analyzed the case material with qualitative methods. Our institutional review board reviewed and approved the study design.

Setting and Selection of Participants

This study took place at the University of New Mexico Health Sciences Center. The Health Sciences Center contains New Mexico's only medical school, and the teaching hospital is the only Level I trauma center for the state and the only public hospital in Albuquerque and Bernalillo County to serve the general public. In 2005, the Health Sciences Center had more than 750,000 visits from 125,000 patients per year, and the ED had 71,594 visits from 48,130 patients.

All patients who were 10 years of age and older who registered for a visit at the Health Sciences Center's ED between February 1994 and November 2004 were eligible for inclusion in the study. The patient also must have been evaluated in the ED, discharged from the ED, and subsequently must have died within the next 7 days or on the day of discharge, and the death must have been reported to the Office of the Medical Investigator, New Mexico's state medical examiner.

Methods of Measurement

To generate a list of included patients, a database was derived by using probabilistic linkage to link 3 databases. Probabilistic linkage uses the statistical properties of variables in a data set to link observations across multiple databases, particularly when unique identifiers cannot precisely link. The analysis database was originally generated for another study. A detailed accounting of the methods that were used to conduct this linkage is reported elsewhere.[7] Briefly, the linked databases were the ED tracking database, the ED billing database, and the medical examiner database of recorded deaths. In New Mexico, death reporting to the medical examiner is mandatory, except for deaths that occur outside of state jurisdiction (federal and tribal lands), in which reporting is at the discretion of the federal entity.

Each of these 3 databases provided unique identifiers and other data that could not be garnered from any single database. The linkage occurred in 2 phases. First, the tracking database and billing databases were linked. Next, the combined database was linked to the medical examiner database of deaths. Cases meeting inclusion criteria were identified. All ED visit material, including physician and nursing notes, was photocopied for case abstraction and qualitative data analysis. Three abstracters (2 senior residents, 1 faculty) read through the medical records and abstracted key case material, including ED visit logs, nursing notes, laboratory and radiology reports, hospital inpatient records, and autopsy case files. Abstracted variables included demographics, ED diagnoses, vital signs, use of consultation, laboratory tests, and a summary narrative of the case.

Before case abstraction, the reviewers met to discuss and standardize abstraction methods and variable definitions. After

abstraction, each abstracter reviewed each case and used a separate 5-point Likert scale to score each visit for whether the death was expected, whether the death was related to the ED visit, and whether an error had likely occurred during the ED visit. The 5-point scale was "unlikely" (1), "probably not" (2), "possible" (3), "probably" (4), and "likely" (5). Expected deaths were those in which a clear pathologic process had been identified and was terminal and untreatable and death was likely to result in a short time (eg, a metastatic breast cancer patient receiving hospice care who came to the ED for pain management and was sent home with treatment). Related deaths were those in which a clear connection existed between the ED visit and the cause of death (eg, a patient who was treated in the ED for abdominal pain, was sent home and later died of mesenteric infarct). Because of the atypical nature of some presentations, the judgment of the reviewers was necessary to provide the foundation for this linkage. When multiple ED visits occurred before death, the last available ED visit with subsequent ED discharge was used for data collection.

Abstracters were blinded to the scoring of the other abstracters. A standard abstracting form was used. A mean of 3.0 or greater on the 5-point Likert scale indicated possible occurrence of an error.

All cases were reviewed for abstractor agreement. In most cases, reviewers' scores were within 2 points, but in a small number of cases (n=15 [13%]), the 3 raters' scores differed by 2 or more points. These 15 cases were discussed among the 3 raters. During this review, 4 cases (3%) had a change in scores. In each of these cases, the outlying rater misinterpreted the written record or missed key findings that the other raters had gleaned from the record. The outlying rater rescored the case according to his or her own criteria.

We defined a possible medical error using the Institute of Medicine's definition in which an error is "the failure of a planned action to be completed as intended (ie, error of execution) or the use of a wrong plan to achieve an aim (ie, error of planning)."[1] However, because we hypothesized that possible error cases might involve incorrect diagnoses or assessments of severity, we also expanded the definition to include failure to solicit or interpret information that would have led to a different action. After initial review and classification of records, those cases that were judged to be unexpected and related to the ED visit were further assessed for problems in care.

Primary Data Analysis

The mortality rates were calculated by dividing the number of deaths per 100,000 visits. Triage acuity was recorded only for visits after March 9, 1997; consequently, mortality rates by triage acuity were calculated for observations after this date. Confidence intervals (CIs) were calculated using the method described by Newcombe.[8] Interrater reliability was assessed with Kendall's[9] coefficient of concordance.

The circumstances and contributing factors of the deaths that were unexpected and related to the ED visit were examined and characterized, and themes were identified using grounded theory.[6] Grounded theory is a basic technique of qualitative research from which the researchers iteratively review the data sources to reveal thematic content contained within the data set (Figure). Importantly, no a priori categorizations are imposed, but rather themes emerge inductively during the analysis. As new themes emerge, all material is iteratively reviewed for supportive and disconfirming evidence. This process terminates when the analyst has exhausted his search for themes. To assist the process, we made notes in the margins of the cases and we created a matrix to summarize the characterizations of these error cases. Specifically, we reviewed the cases for clues or patterns that might be helpful for future scientific study. Through our analysis of the case material, certain issues repeatedly emerged and were interpreted as potential explanations for death. These explanations had not been discussed or suggested for inclusion before the analysis but rather became evident spontaneously. Grounded theory was initially applied to cases with error scores greater than or equal to 3.0; this approach was then applied to cases with error scores below 3.0. We then grouped and tabulated all cases (see Figure).

RESULTS

During the study period, there were 387,334 visits among 186,859 individual patients (average of 2.1 visits per patient) (Table 1). Half were male patients; the overall average age was 39.7 years (SD 15.5 years). The median number of days between discharge to home and death was 3 days; the mean number was 3.8 days.

We identified 149 deaths among 387,334 ED visits with home discharge (38.5 deaths within 7 days of discharge for every 100,000 ED discharges home; 95% CI 32.8 to 45.2 deaths) (Table 1). After manual record review of these cases, we removed 15 patients who were admitted rather than being discharged home and 2 cases that were inaccurate links, leaving 132 patients (34.1 deaths within 7 days for every 100,000 discharges home; 95% CI 28.7 to 40.4 deaths). Of these, 15 medical records could not be located, resulting in 117 patients (79%) for detailed study, representing 30.2 deaths within 7 days for every 100,000 discharges home (95% CI 25.2 to 36.2 deaths).

Before adjudication of discrepant scores, agreement among the raters about whether the death was expected (Kendall's coefficient 0.91) or related (0.93) or whether a possible error (0.91) had been made was excellent. Of the 117 cases, 17 (15%) were expected deaths, 75 (64%) patients died from a condition related to the ED visit, and 58 (60%) patients died of a condition that was related and unexpected. Of these 58 cases, 35 (60%) had a possible medical error. For the unexpected, related cases, there were 15.0 deaths within 7 days for every 100,000 discharges home (95% CI 11.6 to 19.4 deaths). In the possible medical error group, there were 9.0 deaths per 100,000

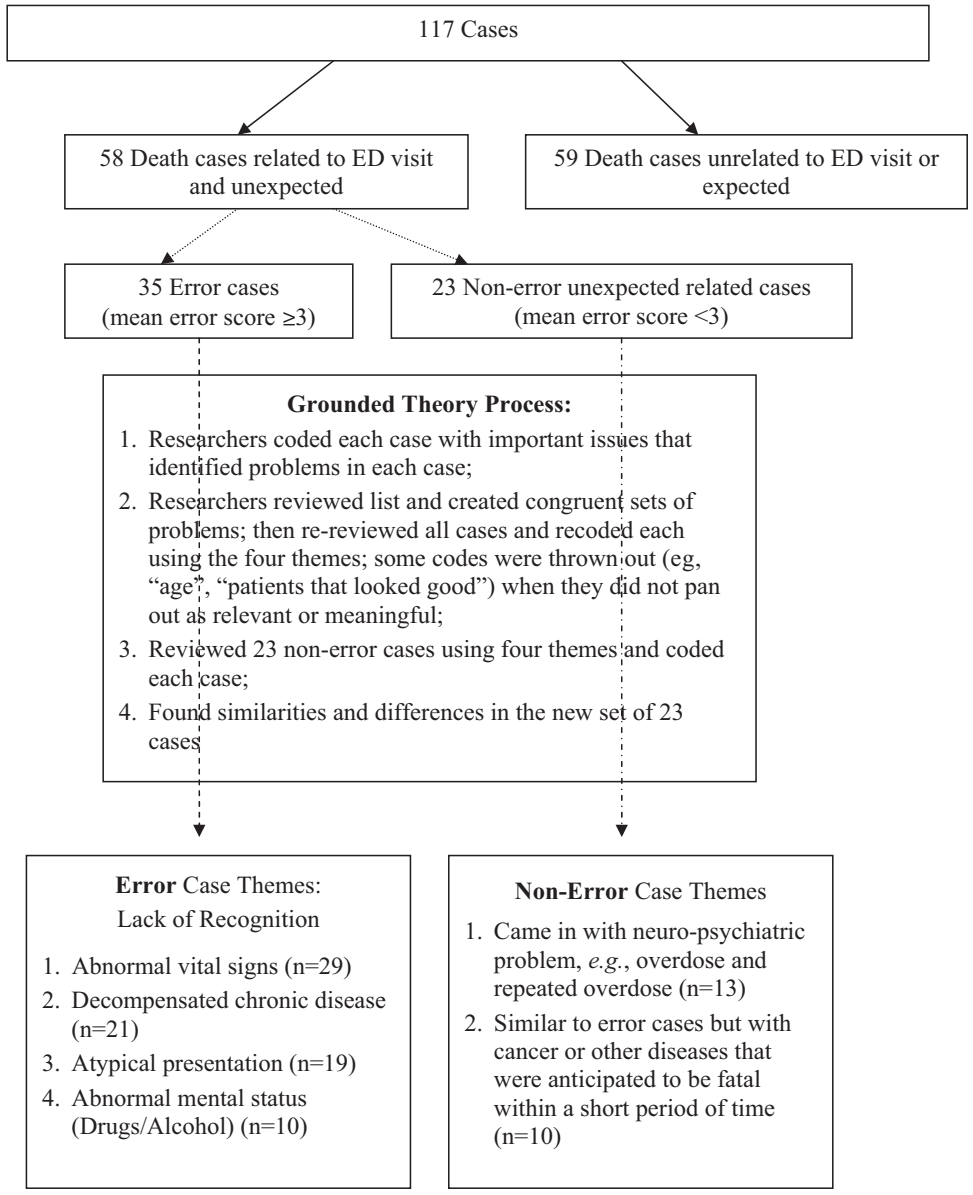

Figure. Grounded theory process for building of themes.

discharges home (95% CI 6.5 to 12.6 deaths); in the nonerror unexpected/related group, there were 5.9 deaths per 100,000 discharges home (95% CI 4.0 to 8.9 deaths).

Full autopsies were performed in 59 of 117 (50%) patients. Forty-eight (48) patients (41%) had no autopsy examination. An external examination only was conducted in 10 (9%) patients. Among the unexpected, related cases, 30 of 58 (52%) had a full autopsy, 6 (10%) had an external examination, and 22 (38%) had no autopsy. Among possible error cases, 18 of 35 (51%) had an autopsy. Three possible error cases had external examinations only. Among expected death cases, only 1 of 17 (6%) had an autopsy.

The mean age of the cases at death for the possible error unexpected, related (48.8 years); the nonerror unexpected, related (47.9 years); and the unexpected, unrelated cases (48.5 years) was similar. The expected death group, however, was older (56.2 years).

Diagnoses for the possible error cases (Table 2) included 11 cardiac diagnoses (coronary artery disease/atherosclerotic heart disease [n=6], congestive failure [n=1], myocardial infarction [n=2], endocarditis [n=1], cardiomyopathy [n=1]). There were 6 central nervous system deaths (subdural [n=2], intracerebral bleeding [n=2], seizure [n=1], and meningitis [n=1]). One of the 2 intracerebral bleeding deaths occurred

Table 1. Mortality rates for patients discharged to home.

Characteristics	Discharges Home (N)	Deaths Within 7 Days of Discharge (N)	Mortality Rate	95% CI
Total discharges home	387,334			
Initial case group		149	38.5	32.8–45.2
Final case group		117	30.2	25.2–36.2
Unexpected		77	19.9	15.9–24.8
Related		75	19.4	15.4–24.3
Unexpected and related		58	15.0	11.6–19.4
Problems in care		35	9.0	6.5–12.6
Triage acuity*				
A	3,114	2	64.2	17.6–233.9
B	48,051	31	64.5	45.5–91.6
C	207,045	66	31.9	25.1–40.5
D	7,011	3	42.8	14.6–125.7
Missing	422	0		
Sex				
Male	184,573	86	46.6	37.7–57.5
Female	202,632	63	31.1	24.3–39.8
Missing	129	0		
Age group, y				
<25	48,599	8	16.5	8.3–42.5
25–44	201,203	54	26.8	20.6–35.0
45–64	106,031	59	55.6	43.1–71.8
≥65	31,501	28	88.9	61.5–128.4

*Triage acuity available after March 9, 1997.

during the treatment for a patient who had had a missed myocardial infarction (the ED error was related to the missed diagnosis of myocardial infarction; the medical examiner ruled the cause of death as an intracerebral bleeding caused by anticoagulation). There were 6 abdominal/gastrointestinal causes (1 each gastrointestinal bleeding, peritonitis, bowel infarct, mesenteric artery infarct, hepatic failure, and abdominal aorta aneurysm). There were 3 pulmonary deaths (pulmonary embolus [n=2], pneumonia [n=1]). The remaining deaths were for a variety of other conditions, including sepsis, acute respiratory distress syndrome, AIDS, and alcoholic liver disease. There was 1 complication of a radiologic procedure (perforation of small bowel during placement of feeding tube, not recognized during the ED visit).

Diagnoses and circumstance of death of the unexpected, related cases not judged to involve error were separated into 2 groups (Table 3). In one group, the death was due to a repeated episode of altered mental capacity, usually associated with substance abuse (n=13). An example of this type of case was a patient who presented for a heroin overdose, was treated and released, and then, 2 days later, died of another, separate overdose. The second group involved illnesses that progressed to death over time. The diagnoses included end-stage liver disease with gastrointestinal bleeding (n=2), complications of cancer (n=4), complications of pneumonia after a fall (n=1), cardiomyopathy (n=1), chronic obstructive pulmonary disease (n=1), coronary artery disease (n=1), and pneumonia in a patient with amyotrophic lateral sclerosis (n=1).

We reviewed the ED case material (autopsy, physician and nursing ED/hospital records), and medical investigator reports for the unexpected, related case to identify themes or possible explanations for the problems of care that occurred. A process of iterative thematic description and thematic grouping was used to identify themes. As themes emerged from cases, they were confirmed or disconfirmed through the repeated review using a matrix for data presence or absence. Four themes repeatedly emerged: atypical presentation of a low-prevalence condition, chronic disease with decompensation, abnormal vital signs, and mental disability or psychiatric problem or substance abuse that may have made it less likely that the patient would return for worsening symptoms (Table 2). Abnormal vital signs occurred in the majority of cases (48/58 [83%]), including 29 of 35 (83%) possible error cases; chronic disease with decompensation occurred in 35 of 58 (60%) patients, including 21 of 35 (60%) possible error cases; atypical presentation occurred in 22 of 58 (38%) patients, including 19 of 35 (54%) possible error cases; and mental illness or substance use occurred in 24 of 58 (41%) patients, including 10 of 35 (29%) possible error cases. All patients had at least 1 of the issues identified above as themes. Five had 1, 34 had 2, 17 had 3, and 2 had all 4 themes demonstrated.

During the qualitative data review, we noted that abnormal vital signs appeared to occur commonly. We developed specific criteria for abnormal vital signs. These definitions were a pulse rate greater than 99 or less than 60 beats per min, a systolic blood pressure greater than 179 or less than 90 mm Hg or a diastolic value greater than 109 mm Hg, a respiratory rate greater than 24 or less than 12 breaths/min, a temperature below 35.0°C (95.0 F°) or above 37.9°C (100.2 F°), and an oxygen saturation of less than 90%. There was 1 mistranscription by the physician of an abnormal vital sign (oxygen saturation of 72% interpreted as 92%). The presence of tachycardia was particularly striking and occurred in 48 of 58 (83%) patients, including 25 of 35 (71%) possible error cases. In comparison to the unexpected unrelated deaths, which were of similar age, tachycardia occurred in 13 of 36 (36%) patients.

The unexpected, related cases not thought to represent errors separated into 2 groups. One group represented a new event of a similar nature to the initial ED visit but was discrete otherwise. Although these deaths were related and unexpected, the relationship was that of a recurrent episodic illness, in most cases alcohol or substance abuse toxicity. Although they represent a significant proportion of ED patients at risk for death, they did not die as a result of any delay of diagnosis or treatment of their initial ED problem. The second group included patients with serious, progressive illness. Problems with

Table 2. Brief case characteristics for the possible medical error cases.

Case	Age/Sex	ED Chief Complaint	ED Diagnosis	Medical Examiner Causes of Death	Chronic Disease	Abnormal Vital Signs	Atypical Presentation	Mental Illness or Substance Use	Days From Discharge
1	44/Female	Hurt neck	Cervical muscle pain	Myocardial infarction, coronary artery disease		x	x		0
2	30/Male	Seizure	Seizure	Seizure disorder of uncertain cause		x	x		0
3	35/Male	Seizure	Seizure, alcoholism	Chronic alcoholism, deep venous thromboses	x	x		x	1
4	42/Male	Back pain	Probable renal contusion	Multiple pulmonary thromboemboli, arteriosclerotic cardiovascular disease		x	x		1
5	59/Female	Headache	Hypertension	Ruptured abdominal aortic aneurysm		x	x		1
6	83/Female	Fingers blue	Orthostatic hypotension	Arteriosclerotic cardiovascular disease	x		x		1
7	35/Male	Seizure	Seizure	AIDS	x	x	x		2
8	63/Male	Short of breath	Short of breath, resolved	Congestive heart failure	x	x			2
9	68/Female	Fall	Wrist fracture	Arteriosclerotic cardiovascular disease	x	x			2
10	32/Male	Abdominal pain	Chronic pancreatitis, alcoholism	Streptococcal bronchopneumonia, chronic peripheral vascular disease, CHF	x	x	x		2
11	44/Male	Vein rupture in leg	Chronic venous stasis, CHF	Lower-extremity cellulitis	x	x			2
12	13/Female	Call back for abnormal laboratory results	Hyponatremia	Spinal meningitis, seizure disorder with falls	x	x		x	2
13	33/Male	Seizure	Seizure	Blunt trauma of head with subdural hematoma	x		x	x	3
14	34/Female	Incoherent	Alcohol intoxication	Hanging		x		x	3
15	40/Male	Abdominal pain	Constipation	Mesenteric infarction	x	x	x		3
16	34/Female	Dizziness, flank pain	Right upper quadrant pain	Ovarian carcinoma		x	x		3
17	65/Female	Dizziness	Labyrinthitis	Pulmonary emboli, diabetes mellitus, hypertension		x	x		3
18	75/Female	Urinary problems	Urinary tract infection	Atherosclerotic cardiovascular disease, portal vein thrombosis	x				3
19	37/Male	Abdominal pain, back pain, vomiting	Gastroenteritis, dehydration	Liver failure and bowel ischemia	x	x	x		3
20	51/Female	Forearm pain	Ulnar neuropathy	Arteriosclerotic cardiovascular disease	x	x	x		3

Table 2. (continued).

Case	Age/Sex	ED Chief Complaint	ED Diagnosis	Medical Examiner Causes of Death	Chronic Disease	Abnormal Vital Signs	Atypical Presentation	Mental Illness or Substance Use	Days From Discharge
21	18/Male	Abdominal pain, coughing blood	Hepatitis	Fulminant hepatitis, Reye's syndrome		x	x		3
22	54/Male	Fall	Alcoholic liver disease	Acute cerebellar hemorrhage, bicuspid aortic valve	x	x	x	x	4
23	48/Male	Weakness and fatigue	Weakness	Acute myocardial infarct complicating infective endocarditis					4
24	49/Male	Bilateral arm pain	Bilateral forearm tendonitis	Arteriosclerotic cardiovascular disease with acute myocardial infarction and anoxic brain damage, anticoagulated for atrial fibrillation		x	x	x	4
25	54/Female	Chest pain	CHF exacerbation	Spontaneous intracranial hemorrhage, sepsis, alcohol liver disease	x	x			5
26	51/Male	Abdominal pain, blood in stool	Internal hemorrhoids	Upper gastrointestinal bleeding	x	x	x	x	5
27	38/Male	Abdominal pain	Alcoholic hepatitis	Peritonitis	x	x			5
28	44/Male	Cough, chest pain	Bronchitis	Complications of chronic alcoholism	x	x		x	5
29	80/Female	Short of breath, chest pain	Chest discomfort	Complications of acute myocardial infarction		x	x		5
30	35/Female	Back pain	Back pain	Anoxic encephalopathy		x	x		5
31	50/Female	Short of breath	Small bowel obstruction	Adult respiratory distress syndrome, complications of small bowel perforation and hypotension	x	x			6
32	65/Female	Tube fell out	J-tube replacement	Bowel ischemia and necrosis				x	6
33	44/Male	Abdominal pain	Schizophrenia	Dilated cardiomyopathy				x	7
34	59/Female	Short of breath	COPD	Coronary artery disease	x	x			7
35	89/Female	Fall	Dehydration, CHF exacerbation	Arteriosclerotic cardiovascular disease with congestive heart	x	x			7

CHF, Congestive heart failure; *COPD,* chronic obstructive pulmonary disease.

care were identified and, like the possible error cases, included abnormal vital signs, decompensation of their chronic disease, atypical presentation of complications of their chronic disease, and one case in which significant mental impairment may have reduced the opportunity for return to medical attention, with worsening symptoms. In many of these cases, although immediate death was not anticipated, the seriousness of their chronic conditions made their death unsurprising.

Table 3. Brief case characteristics for the nonerror unexpected related cases.

Case	Age/Sex	ED Chief Complaint	ED Diagnosis	Medical Examiner Causes of Death	Chronic Disease	Abnormal Vital Signs	Atypical Presentation	Mental Illness or Substance Use	Days From Discharge
Repeated event, nonerror cases									
36	27/Male	Seizure	Seizure	Drowning, seizure disorder, traumatic brain injury	x			x	1
37	39/Male	OD	Methadone OD	Ethanol withdrawal syndrome		x		x	2
38	53/Male	r/o Heroin OD	OD	Drug (cocaine) intoxication		x		x	2
39	36/Male	Motor vehicle crash	Right arm pain, motor vehicle crash	Hydrocodone and zolpidem poisoning		x		x	2
40	48/Male	Altered mental status	Pt left before discharge	Acute and chronic alcoholism				x	2
41	43/Male	EtOH withdrawal	Alcohol intoxication	Anoxic encephalopathy with alcohol intoxication, acute and chronic alcoholism	x	x		x	3
42	37/Female	OD	OD	Mixed drug (methadone and cocaine) intoxication		x		x	3
43	56/Male	ETOH intox	Alcohol intoxication, drug OD	Complications of acute and chronic alcoholism				x	4
44	42/Male	Back pain	Muscle spasm	Gunshot wound of chest, depression		x		x	4
45	33/Male	Trach problem	Trach in place	Asphyxia, obstruction from tracheal fibrosis, remote tracheotomy for pneumonia	x			x	4
46	38/Male	Detox	Alcohol abuse	Complications of chronic alcoholism	x	x		x	4
47	30/Male	Altered mental status	Alcohol intoxication	Acute alcohol intoxication		x		x	6
48	42/Male	Back pain	Chronic back pain	Drug (morphine) and alcohol intoxication		x		x	6
Other nonerror cases									
49	52/Male	Short of breath	Pneumonia	Bronchopneumonia, amyotrophic lateral sclerosis	x	x			2
50	49/Male	Pneumonia	Atypical pneumonia	Carcinoma of the liver	x	x	x		2
51	55/Female	Mouth bleeding	Osteosarcoma left jaw, oral bleeding resolved	Complications of osteosarcoma of jaw	x	x	x		2
52	67/Female	Short of breath	Bronchitis	Ischemic heart disease	x	x			5
53	41/Female	Legs swollen	ESLD	Complications of primary sclerosing cholangitis	x	x			5

Table 3. (continued).

Case	Age/Sex	ED Chief Complaint	ED Diagnosis	Medical Examiner Causes of Death	Chronic Disease	Abnormal Vital Signs	Atypical Presentation	Mental Illness or Substance Use	Days From Discharge
54	62/Female	Thigh pain	Leg pain, unknown cause	Pneumonia, adenocarcinoma of lung	x	x	x		7
55	65/Male	Abdominal pain	Hyperkalemia	Arteriosclerotic cardiovascular disease	x	x			7
56	49/Male	Called by physician	Hyperglycemia	Adenocarcinoma of colon	x	x			7
57	57/Male	Body swelling	End stage renal disease	Spontaneous bacterial peritonitis, end stage alcoholic and viral liver disease	x	x			7
58	80/Female	Fall	Clavicle fracture	Pneumonia, left clavicle fracture	x	x		x	7

OD, Overdose; *r/o,* rule out; *ESLD,* end stage liver disease; *OD,* overdose; *Trach,* tracheostomy.

LIMITATIONS

Our method of case identification required that patients who visited the ED and died be listed in the medical examiner database. The state medical examiner does not have jurisdiction, however, over deaths that occur on Indian reservations nor on federal lands such as military bases. Some American Indian deaths may have been missed in this way. Also, patients who died outside the state would be missed by our identification process.

We used 7 days as our cutoff in this study because Kefer et al[5] used a similar endpoint, and we wanted to compare our results to that study even though our ascertainment methodology was different. Kefer et al[5] depended on the medical examiner to note a previous ED visit in their case summary. This dependence on medical examiner documentation of a previous ED visit likely underestimated the number of these patients because information about ED visits may not have been reported to the medical examiner, particularly if the decedent was homeless, single, or otherwise disconnected from a social support system.

Autopsies were conducted in 50% of cases. Although many of the cases without autopsy were expected death cases with known fatal conditions, there were some cases in which the cause of death could only be presumed due to previous medical conditions or hospital course. We realize that there is some uncertainty in the cause of death, particularly among patients who did not receive an autopsy.[10,11] We reviewed every case with one of the medical examiners to verify the cause of death and the evidence for it. In many cases without an autopsy, the patient died in the hospital and had had several diagnostic tests, including computed tomography scans, laparotomy, and biopsy, which confirmed specific conditions before their death and strengthened the medical examiner's cause-of-death designation. Also, many cases that did not have a complete autopsy had an external examination, which may have identified important facts about cause of death.

We assessed each case for possible error, the relatedness of the death to the previous ED visits, and whether the deaths were a reasonably expected event. Each of these assessments was left to the professional judgment of the reviewers. There is likely variability in the way that these assessments were made, even with a standard definition being used. Nonetheless, among these 3 reviewers, there was good agreement.

Cases were reviewed retrospectively with the knowledge of a fatal outcome and comorbid conditions. These factors may have biased the judgment of the reviewers. Caplan et al[12] have shown that knowledge of outcome can affect the judgment of reviewers about the appropriateness of care. Finally, because of the limitations of a medical record review, we cannot say with certainty whether actions or solicitations of information that were not documented occurred, such as rechecking of vital signs or obtaining critical historical information. For this reason, our judgments about medical errors should be viewed with some caution.

DISCUSSION

Because most patients who are treated in EDs are discharged to continue their convalescence at home, their ultimate outcome is an important measure of the overall care provided in the ED. Patients who die after release from the ED make up the group with the most dire consequences after their visit. Although there have been some studies of patients who return to the ED,[13,14] there is little information about patients who die after an ED visit.[5] Most important in addressing this group is determining

whether the death after the visit might have been prevented and whether problems with care or possible errors contributed to the deaths. Most patients die of conditions that were expected to cause death, such as cancer, or die of completely unrelated causes; for example, a patient treated for an upper respiratory infection might die in a motor vehicle crash. About half of deaths, however, appeared to be unexpected and related to the visit, and about 60% of these cases were associated with a possible error.

Our study suggests that the number of patients who die within 7 days of an ED visit is 30 per 100,000 discharges, more than twice the number previously described (13 per 100,000 discharges).[5] The higher rate observed in our study may represent a more complete case identification method. The previous study identified ED visits from the medical examiner's file. In contrast, we collected data for a large cohort of patients who were treated in the ED and then linked their records to mortality data.

We next used grounded theory, which is a qualitative data analysis technique, to identify themes present in the case material. The method identifies themes without a priori hypotheses. This methodology is used extensively in the social sciences, and we applied it to our case materials to identify possible medical error themes. Four themes emerged: abnormal vital signs, chronic conditions with decompensation, atypical presentations of unusual conditions, and mental illness or substance use making return to the ED less likely. We believe that these grouping may be useful in addressing and preventing problems with care in EDs and will briefly discuss them to assist those interested in hypothesis-driven future research.

Abnormal vital signs, particularly tachycardia, occurred commonly in our unexpected related cases and possible error cases. There was rarely a documented explanation for them in the possible error cases or a documented repeated check that demonstrated normalization, although recheck and normalization did occur in several nonerror cases. Abnormal vital signs, however, also occur commonly in ED patients who do not die. Thus, they are likely a sensitive but nonspecific indicator of risk. Their presence should trigger a search for an explanation for their cause. Abnormal vital signs may serve as a clue or indicator of decompensated chronic illness or of severe, acute illness that presents early in its course.[15,16] Recognition of the presence of abnormal vital signs and a cautious assessment of these patients offer an opportunity to prevent bad outcomes in these patients. Future prospective studies of abnormal vital signs in the ED should assess the usefulness of these signs in identifying patients at risk for an adverse outcome.

Another common finding in patients dying unexpectedly of a related problem was the occurrence of chronic disease such as congestive heart failure in patients presenting to the ED. Patients with certain chronic diseases are at increased risk of death, and it may be difficult to distinguish between a steady state and acute decompensation in a patient with severe compromise.[17] In some patients, the state of equilibrium in a serious disease state is quite precarious, and decompensation may not be recognizable even by specialists familiar with the predominant disease.[14] In many of our cases, the ED diagnosis and the cause of death were similar, and the error was in not recognizing the worsening of the chronic illness. In several of our cases, a consultant familiar with the disease and patient recommended discharge of the patient from the ED. This was particularly common in the nonerror cases in which difficult decisions about home or hospital care were made for patients with known potentially fatal diseases. Alternatively, the use of consultation may be a marker for a sicker patient, a more confusing clinical presentation, or a less experienced or confident emergency physician.

A third common issue was the atypical presentation of relatively low-prevalence disease or complications of disease. In our study, there were cases of pulmonary emboli presenting with dizziness and no chest pain or shortness of breath. There was a patient with a myocardial infarction who presented with pain in the back of the neck only, without chest pain or shortness of breath. There was a patient with endocarditis who did not have fever or heart murmur. Such cases did reveal clues such as abnormal vital signs or abnormal laboratory tests, but the physicians were not able to interpret these clues, because of the atypical nature of the presentation. Bayes' theorem suggests that, when one is faced with a low-probability event, such as endocarditis, unless a highly specific finding with a high likelihood ratio is present, such as a loud murmur with high fever, the diagnosis does not have a high enough probability to suggest endocarditis or even prompt further specific testing such as an echocardiogram or blood cultures.[18] These atypical presentations of low-prevalence diseases will likely continue to be the source of errors leading to death but should be studied to identify new ways to improve diagnostic accuracy with newer tests or new approaches. Rusnak et al[19,20] identified atypical presentation as a major risk for litigation in myocardial infarction and appendicitis cases in emergency medicine. Characterization of atypical presentations and development of strategies to identify those patients most at risk should be considered as part of an error reduction plan.

Finally, we noted a substantial portion of patients who had psychiatric disability, mental disability, or substance abuse associated with their medical problem. As we reviewed these cases, we observed that these patients did not return to the ED, even though their conditions worsened. Many of these patients had a long history of alcohol or drug use, which may have impaired their ability to interpret their worsening condition. These cases would suggest that vulnerable patients with severe mental or social risk should be considered for hospital observation or admission even if certain usual criteria for admission are absent. Social factors have been included in a variety of algorithms for admission for conditions such as pneumonia[21] and congestive heart failure.[22] There was also a

high number of patients with a recurrent episode of substance use shortly after their ED visit, leading to their death. Although these cases were not identified as errors in care, they clearly represent a high-risk population appropriate for new, creative approaches for ED and follow-up care.

The proportion of cases that were unexpected but related (50%) was higher than the 21% reported by Kefer et al.[5] They did not identify the percentage of their cases that involved possible medical error. We believe the difference in our numbers may be due to a more complete recovery of death cases with our methodology. We reviewed all unexpected related cases regardless of their Likert scale error score. Although there may be some value in attempting to identify and classify error cases, a more comprehensive assessment of possible care problems in all unexpected related deaths may provide a greater yield of opportunities for improvement in care.

Detection of medical error and prevention of the consequences of medical error have been elevated to a high national priority. Probabilistic linkage technology is one tool that can be applied to this problem, especially in instances in which data sets are large and when unique identifiers that could link the data sets using exact criteria do not exist. Methodologies that include the monitoring of death records may also be helpful to ED quality improvement programs at individual institutions. Through linkage of ED administrative data to state medical examiner records, our study provides further information on the amount and nature of possible medical error in the ED that is associated with a subsequent death. Our study sets the stage for future hypothesis-driven research to identify, prevent, or mitigate error and reduce the rate of death after ED visit.

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Address for reprints: Cameron S. Crandall, MD, Department of Emergency Medicine, MSC10 5560, 1 University of New Mexico, Albuquerque, NM 87131-0001; 505-272-5062, fax 505-272-6503; E-mail ccrandall@salud.unm.edu.

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