ORIGINAL ARTICLE

Audit of deaths less than a week after admission through an emergency department: how accurate was the ED diagnosis and were any deaths preventable?

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Aim: To review the causes of death in patients admitted via the emergency department (ED) who died within 7 days of admission and to identify any ways in which ED care could have been better. The study also aims to compare the diagnosis made in the ED and the mortality diagnosis.

Methods: A retrospective study; subjects were all patients who attended the ED over 4 months and died within 7 days of admission. The paramedics' notes, ED case cards, inpatient medical notes and details of postmortem findings were examined to identify the time and date of arrival in the ED, presenting complaint, provisional diagnosis made by the ED, treatment plan devised by the ED, diagnosis made in wards, and the cause of death as issued on death certificates or from postmortem findings. Summary sheets of cases where the care provided by the emergency department could have been improved were reviewed, errors were identified and deaths were classified as preventable or unpreventable.

Results: Database revealed 3521 admissions via the ED over 4 months, of which 95 cases (2.69%) died within 7 days of admission. 78 patients (82.1% of cases) were appropriately diagnosed and managed whereas 17 (17.87% of cases) were identified with deficiencies in either the diagnosis or the management provided in the ED. We reviewed the quality of care provided in the ED for these cases and rated deaths according to our preventability criteria: 5 (5.26%) deaths were unpreventable despite the deficiency in care provided in the ED; 3 (3.15%) deaths were definitely preventable; 3 (3.15%) were probably preventable; and 6 (6.31%) were possibly preventable deaths.

Conclusion: The ED is playing a good role in the management of critically ill patients, with appropriate diagnosis and management in 82% of cases. Training of junior doctors is required to prevent occurrence of errors and thus preventable deaths, but all deaths are not preventable. New guidelines for sepsis management and management of undifferentiated clinical presentations are being introduced and we intend to audit the implications of new guidelines.

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As a major route for hospital admission, the emergency department (ED) requires its doctors to be both "Jack" and "the Master" of all acute trades. Emergency medicine can be more intense and stressful than that practised on the wards. The ED is a tactical environment requiring an efficient and direct style which thoroughly addresses immediate problems and admits little room for error.

Medical errors are one of the most serious problems affecting the health care system and are associated with considerable impact on the long term health of individual patients and the standing of our medical profession. Errors have the potential to compromise the physician–patient relationship and undermine the overall trust in the health care system. The important step is to identify an error, accept it and take necessary measures to correct and prevent it occurring in the future. Individuals are rarely solely responsible for such errors and it is the systematic errors that need identification and correction.

The aim of this study was to review the deaths in patients attending the ED and dying within 7 days of hospital admission. We aimed to define preventability criteria and identify any preventable deaths because of deficiencies in care provided in the ED in terms of misdiagnosis, delay in diagnosis, delay in management and error in management in the ED. The study also compares the diagnosis in the ED to the final diagnosis as issued on the death certificate after the coroner's opinion or postmortem.

METHODS

A retrospective study was undertaken, under the auspices of audit, at the ED of Peterborough District Hospital. A computerised search of the database was made to uncover all patients who attended the ED over 4 months in 2005 and had died within 7 days after emergency admission. The department has an annual attendance rate of 65 000 and serves a wide catchment area between Leicestershire, Lincolnshire and Cambridgeshire.

For all patients who died within 7 days of admission into hospital via the ED, the paramedic notes, ED case cards, hospital notes, death certificate book entries and postmortem details were examined against a checklist. The details of time of arrival and death, presentation in the ED, diagnosis and management in the ED, diagnosis and management in medical wards, development of any subsequent medical problem, and cause of death as on the death certificate were summarised in the summary sheets for each patient separately. The case notes were reviewed by the first author (TN) and the summary sheets were filled in according to the findings in hospital notes. Summary sheets were then reviewed independently by two consultants in the ED who were blinded to the patient's details. After individual assessment of summary sheets, the assessors

Abbreviations: DKA, diabetic ketoacidosis; ED, emergency department; GI, gastrointestinal; IHD, ischaemic heart disease; LVF, left ventricular failure; NSTEMI, non-ST elevation myocardial infarction

were asked to identify the errors in diagnosis and/or management and classify the deaths. To define and classify preventable deaths, we used the scoring for the typology of critical incidents by Thomas *et al.*¹ We modified the typology in accordance to our study and classified deaths into four categories as shown in table 1. The level of severity of critical incidents as described by Thomas *et al* ranges from 1, generally for a life threatening situation, to 5, generally corresponding to failures where no harm occurs.¹ We classed severity levels 1 and 2 as definitely preventable, level 3 as probably preventable, level 4 as possibly preventable, and level 5 as unpreventable death.

Our study did not include people who had no pulse before arrival in the ED and could not be successfully resuscitated. The study included people who arrested within the department or were successfully resuscitated following a pre-hospital cardiac arrest.

This method gave us the opportunity to identify the common errors in the ED but, at the same time, to view the implications of such errors on patients. The study allowed us to compare the diagnosis made by the ED doctor to the provisional diagnosis made on the wards (medical/surgical team) and the final diagnosis as stated on the death certificate or after autopsy examination, and also to review the quality of care provided to the critically ill in our ED.

RESULTS

The department saw 19 025 patients during the study period and the total admissions via the ED during this period were 3521 (18.5%). The database revealed 95 patients (2.69%) admitted via the ED who died within 7 days of admission.

The cause of deaths as issued on death certificates or after autopsy is shown in fig 1. Most deaths were due to respiratory problems such as bronchopneumonia (15), chronic obstructive pulmonary disease (3), respiratory failure secondary to pneumonia (2), respiratory failure secondary to acute respiratory distress syndrome (2) and pulmonary embolism (2), with hemorrhagic and ischaemic strokes being the second most common cause of deaths (20). Cardiovascular causes included acute myocardial infarction (9), ischaemic heart disease (IHD) (2), left ventricular failure (LVF) secondary to IHD (6), and LVF complicated by lower respiratory tract infection (2). The median age was 77 years (range 26–95 years), with a male:female ratio of 1:1.1. The time period from presentation in the ED to the time of death as reported in the case notes is shown in fig 2. Our study revealed 82.1% (78) patients who died following emergency admission were adequately diagnosed and managed in the ED; 13.6% (13) cases were misdiagnosed and 4.2% (4) had an unclear diagnosis. Among the cases that involved errors

in the ED, 5.26% were unpreventable deaths, 3.15% deaths were definitely preventable, 3.15% were probably preventable and 6.31% were possibly preventable deaths. The deaths were classified by two assessors who were blinded to each other’s comments and there was no disagreement between them. Table 2 compares the diagnosis by ED, diagnosis in ward (after the post-take round) and at death, the type of error and preventability among the 17 cases where we identified deficiencies in the care provided in the ED.

The use of DNR (do not resuscitate) orders has been increasing in the elderly over the past few decades. In our study 75 patients had DNR orders written after admission; 35 (46.66%) patients were written for DNR within 12 h of admission. The presentation and associated co-morbidities are generally considered for not-to-resuscitate candidates, and we collected our data from the DNR forms in case notes.

DISCUSSION

We wanted to identify any errors in ED assessment with effect on mortality, in non-trauma cases. Previous studies based on errors in the ED were mostly based on misdiagnosis and inappropriate management of fractures. By concentrating on detection of preventable deaths, we wanted to find an opportunity to identify faults in the system rather than blaming individuals. In our study group, 14.5% of emergency admissions to our hospital were misdiagnosed and 4.2% had an unclear diagnosis. Despite the large number of misdiagnoses, adequate management was still provided in most cases and we felt the need to identify the errors that resulted in morbidity and mortality and classify the term “preventable deaths”. Preventable deaths have been subclassified in trauma patients in a previous study by Chiara *et al.*² We classified preventable deaths as discussed earlier in table 1. We define unpreventable death as a death where error in assessment and/or management provided by the ED did not have an adverse effect on the final outcome.

Emergency medicine is a high risk specialty and unexpected deaths following emergency admission are not uncommon in medical practice. Although it is generally implied that errors are responsible for unexpected deaths, we disagree, unless the errors led to mismanagement (missing ST elevation on ECG, therefore not treating the underlying cause), inappropriate resuscitation, etc. Resuscitative measures in ED patients are by nature generic, based on the ABC approach to the undiagnosed patient or for a wide differential diagnosis. The definition of an error is failure of planned action to be executed or the use of the wrong plan to achieve the intended action. Errors are classified as active and latent errors.³ Active errors are events occurring around the incident with immediate effects, and latent errors

Table 1 Preventability criteria			
Definitely preventable	Probably preventable	Possibly preventable	Unpreventable
Failure to make diagnosis in patients with life threatening consequences	Failure to make diagnosis in patients with potentially life threatening consequences. Failure to make diagnosis which significantly changes treatment	Failure to make diagnosis of condition associated with severe illness, resulting in delay but does not change treatment	Failure or delay in patient assessment resulting in or likely to result in, no harm
Delay in patient assessment with life threatening consequences	Delay in patient assessment with potentially life threatening consequences	Delay in assessing patient with severe illness or morbidity	Delay in patient assessment resulting in no harm
Inappropriate investigations or treatment in life threatening situations	Inappropriate investigations or treatment in potentially life threatening situations	Inadequate investigations or treatment resulting in unnecessary delay	Inappropriate investigations or treatment resulting in or likely to result in unnecessary delay but no harm
Failure to admit patients with life threatening situation into intensive care or high dependency units	Failure to admit patients with potentially life threatening situation into appropriate high dependency units	Failure to admit patients in appropriate wards or inappropriate referral resulting in unnecessary delay	Failure to admit in appropriate wards, resulting in no harm
Modification of typology of critical incidents after permission from author.

Figure 1 Primary cause of death as stated on death certificates. AAA, abdominal aortic aneurysm.

are errors caused by the system containing unrecognised faults such as incorrect policies, failure of training, or inadequate supervision.⁴ Active errors are further subclassified into knowledge based errors (inadequate knowledge), rule based errors (inappropriate rule is in place, like detached ECG leads during cardiopulmonary resuscitation) and skill based errors—that is, slips (unintended actions) or mistakes (faulty or poor planning). We agree with the definition of diagnostic error defined by Guly,⁵ but all deaths cannot be labelled definitely preventable even if there was an error in the initial assessment by the ED doctor.

The ED sees a lot of undifferentiated cases over a short period of time. In non-trauma patients, reaching a definitive diagnosis is often difficult in the ED due to time constraints, as observation and investigative workup is required in most cases before diagnosis is made and an appropriate management plan is devised. Indeed, it is more appropriate in the ED to carry out resuscitation based on patient presentation and potential differential diagnoses than to focus on definitive diagnosis before treatment. The government set 4 h target has reduced the time available although it has had valuable effects elsewhere in the ED. If such patients were inadequately assessed in the ED and were discharged from hospital, this would constitute an error.

Lu *et al* in a study in Taiwan⁶ screened early mortality as death within 24 h. The study reported 0.4% mortalities within 24 h of emergency admission. We have used 1 week (7 days) as a cut off for our study group to allow a higher chance of picking up latent errors. The time interval between presentation to ED and time of death, as documented on death certificates, is shown in fig 2. It was revealed that 26.3% of the patients died on the seventh day of admission and the majority of the deaths were related to respiratory problems, either on their own or following a cerebrovascular event. In addition to 24.2% of deaths occurring within 24 h, we found that 40% of deaths occurred between 24–72 h, which is a large number. Defining early mortality can be difficult and we feel that more research with a larger study group is required to derive a widely accepted classification.

Among the cases described in table 2, most were straightforward cases, where errors in ED diagnosis or management were clear to the assessors and the deaths were classified according to the preventability criteria. The case of undifferentiated abdominal pain (case 16) was misdiagnosed in ED as well as on the surgical unit due to lack of clinical findings. This case highlights the difficulties in reaching an early diagnosis within a given time in ED, and furthermore emphasises the need for appropriate investigations to reach a diagnosis. A similar case in the past

Figure 2 Time interval between arrival in the emergency department and death.

led to some admission guidelines within the trust, and more guidelines are being introduced for the education of junior doctors in the assessment of undifferentiated clinical presentations. In cases 4 and 7 shown in table 2, we observed that the presenting complaint to the ED was that of shortness of breath and chest pain. These cases were misdiagnosed in the ED because of improper x ray interpretation and the resulting mortality was classified according to our preventability criteria. It was difficult to obtain diagnostic information from case 11 because of a reduced level of consciousness and the patient died within 10 h of presentation to the ED. The death was classified as unpreventable based on the clinical presentation and the appropriate management given in the ED despite the discrepancy in diagnosis.

One of the limitations of our study is that we could not retrieve information on errors on those patients who attended our ED and were referred to other hospitals and died there. The database revealed 35 cases that were referred to other centres in this period. Among these cases, radiological investigations in our department confirmed three intracranial bleeds, one intracranial lesion and one liver injury. The remaining patients were referred for traumatic injuries and are alive and well. We are not aware of any patients dying following discharge from the ED over the study period.

Studies have showed that it is difficult to predict the accurate cause of death and there may be discrepancies between the anticipated cause of death by the ED doctor and autopsy findings.⁷ A study by Mushtaq and Ritchie revealed that 39.7% of cases were inaccurately predicted by the ED physician.⁸ In our study group a postmortem examination was performed in 11 cases (11.5%). The diagnosis in the ED was accurate in seven of these cases. Table 3 compares the ED diagnosis versus the postmortem findings.

The mortality details were collected from the death certificate book and postmortem reports. Death certificates have a limited role as a source of mortality statistics⁹ as patients frequently die of causes unrelated to the pre-existing problems. It was noted that respiratory and cardiovascular causes were the most common cause of death reported in certificates in agreement with the coroner's opinion. The death certificates were generally issued on the basis of diagnosis in the ward and existing comorbidities. One should take into account that a few of these patients were originally admitted with cerebrovascular accident or liver disease and later died with cardiorespiratory problems; we labelled such deaths as accurately diagnosed. One case in our study group was diagnosed as having diabetic ketoacidosis (DKA) by the ED doctor and physician on the ward. While being managed for DKA, the patient was later diagnosed with non-ST elevation myocardial infarction (NSTEMI) following raised cardiac markers 13 h after admission. We were not able to determine if the cause of death was an error in diagnosis or a subsequent development of NSTEMI. This case highlights the importance of documentation in notes about the presenting complaint, appropriate history taking and

Table 2 Comparison of diagnosis with mortality diagnosis and type of preventability in cases where deficiencies were identified – 17 cases

ED diagnosis	Ward diagnosis	Mortality diagnosis	Error	Preventability
1. LVF ± LRTI	Acute on CRF	Acute renal failure	Error in diagnosis	Unpreventable
2. ? Bronchogenic Ca ± pleural effusion	Pleural effusion ± lung carcinoma	Bronchopneumonia + lung collapse	Error in diagnosis	Possibly preventable
3. LVF ± aspiration	Clear cell carcinoma	Clear cell carcinoma	Error in diagnosis	Unpreventable
4. ACS	LRTI + COPD exacerbation	Pneumonia	Error in diagnosis	Possibly preventable
5. Unclear – collapse ? cause	Pneumonia ± sepsis	Sepsis + pneumonia	Error in diagnosis Delay in treatment	Definitely preventable
6. Collapse ? cause ? CVA	Collapse ? sec to metabolic abnormality	Sepsis + acute renal failure	Delay in diagnosis	Unpreventable
7. ? ACS ? PE	LRTI	Sepsis + pneumonia	Error in diagnosis	Possibly preventable
8. Heart block + COPD exacerbation	Hypothermia + pneumonia + coexisting heart block	B/L bronchopneumonia	Error in diagnosis Error in treatment	Possibly preventable
9. Unclear	Collapse ? cause	Pulmonary embolism + cardiac arrest	Error in diagnosis	Possibly preventable
10. Unclear	? Septicaemia	Myocardial infarction + subdural haematoma	Error in diagnosis Inadequate investigations	Definitely preventable
11. ? NSTEMI	Metabolic acidosis + sepsis	Sepsis	Error in diagnosis	Unpreventable
12. Urinary tract infection	LRTI ± aspiration	LRTI + sepsis	Error in diagnosis Delay in treatment	Probably preventable
13. LVF	PE	PE	Error in diagnosis	Probably preventable
14. Hypothermia	Hypothermia + anaemia ? cause	Upper GI bleed—postmortem report	Error in diagnosis	Possibly preventable
15. General deterioration	Type 2 respiratory failure + emaciation	Sepsis	Error in diagnosis	Unpreventable
16. Abdominal pain? cause + COPD exacerbation	? Peptic ulcer disease	Leaking AAA—postmortem report	Error in diagnosis Inadequate investigations	Definitely preventable
17. Worsening renal failure	Renal failure	Dysrhythmia + thrombus right auricle—postmortem report	Error in diagnosis	Probably preventable

AAA, abdominal aortic aneurysm; ACS, acute coronary syndrome; COPD, chronic obstructive pulmonary disease; CRF, chronic renal failure; GI, gastrointestinal; LRTI, lower respiratory tract infection; LVF, left ventricular failure; NSTEMI, non-ST elevation myocardial infarction; PE, pulmonary embolism.

clinical examination, and also the reasoning for ordering investigations. It is not surprising that the diagnosis can change as the diagnostic workup progresses.

One of the limitations of our study is hindsight bias. It is easier to point out errors in retrospect when we know the final outcome. The purpose of the study is not to point fingers but to identify the errors in the ED. A few deficiencies in our ED case card documentation by junior doctors came to our attention which certainly will help in the teaching of junior doctors in the future and will improve the quality of care provided in the ED. Inevitably the evidence for the cause of death required qualitative assessment of the available documentation and we relied on the accuracy and completeness of clinical note

keeping. There may have been other findings that the certifying doctor may have used to establish the cause of death that were not recorded (verbal discussion with the general practitioner, verbal request for ordering investigations, clinical findings, etc); this is another limitation of our study.

Figure 3 highlights the time when the preventable deaths arrived in the ED. Among the preventable deaths, three cases were identified as definitely preventable, two cases were identified as probably preventable, and four cases of possibly preventable deaths presented to the ED between 20.00–08.00 h. This study has given us an opportunity to review our practice and training of junior doctors in our ED. Radiographic findings and interpretation of ECG and blood gases should be documented in ED case cards and senior supervision should reduce the errors caused by misinterpretation of clinical finding and investigations. The planned appointment of further staff grade doctors and consultants may facilitate this. Cases where

Table 3 Comparison of emergency department (ED) diagnosis with mortality diagnosis on the postmortem report

ED diagnosis	Cause of death on postmortem report
Undifferentiated abdominal pain	Intra-abdominal haemorrhage secondary to rupture AAA
Collapse ? cause	Recent MI + LVF
Acute confusion secondary to epileptic attack	IHD + known epilepsy
CVA	Subsequent MI + CVA
Lung carcinoma	Mesothelioma
Haemorrhagic stroke	Massive intracranial bleed
Pulmonary vessel disease	Pulmonary hypertension
Hypothermia + anaemia ? cause	Upper GI bleed
Liver disease + obstructive jaundice + peptic ulcer	IHD + upper GI bleed + gall stones
Renal failure	Dysrhythmia + thrombus right auricle
Respiratory arrest following drug overdose	Multiorgan failure + coproxamol overdose

AAA, abdominal aortic aneurysm; CVA, cerebrovascular accident; GI, gastrointestinal; IHD, ischaemic heart disease; LVF, left ventricular failure; MI, myocardial infarction.

Figure 3 Time of the day "preventable deaths" attended the emergency department.

the patients are unwell or diagnosis is unclear should be reviewed by senior members of the team before a referral is made. We are developing guidelines for the assessment of undifferentiated clinical presentations to improve the training of junior doctors and also prevent mortality from common treatable medical conditions. Further study is required on a wider group with follow up of referred patients to identify errors leading to mortality and morbidity, to define early mortality, and to identify the preventable deaths. We have subsequently carried out additional staff teaching on sepsis management and the trust is introducing new guidelines based around the "Surviving Sepsis" campaign.¹⁰ The department will review its performance in a few years.

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IMAGES IN EMERGENCY MEDICINE

Intrathoracic lipoma in a child

M Whitlock, Kiran A Qureshi

A 10-year-old girl presented with a 2 week history of right sided chest pain, which was pleuritic in nature. On examination, the child was found to have absent breath sounds and absent vocal fremitus over the right upper chest. A plain chest radiograph (fig 1) showed a large homogenous mass in the upper half of the right lung field. A computed tomographic (CT) scan of the chest revealed a large mass compressing and distorting the right upper lobe. A provisional diagnosis of intrathoracic lipoma was made. The child underwent thoracotomy and enucleation of the lipoma. Postoperatively the child had an uneventful recovery.

Intrathoracic lipoma is a rare neoplasm. They frequently present with

Figure 1 Chest radiograph showing a large homogenous mass in the upper half of the right lung field

incidental radiographic findings, confounding clinical decisions.¹ A CT scan is considered the investigation of choice. World literature review supports complete excision for diagnostic and therapeutic purposes.

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