

# Emergency department care-related causal factors of in-patient deterioration

Kirollos Nassief<sup>1,6,7</sup> MD, Junior Medical Officer

Mark Azer<sup>2</sup> MD, Junior Medical Officer

Michael Watts<sup>3</sup> BN, Registered Nurse

Erin Tuala<sup>3</sup> MN, Clinical Nurse Consultant

Peter McLennan<sup>1</sup> PhD, Professor of Physiology

Kate Curtis<sup>3,4,5</sup> PhD, Professor of Trauma and Emergency Nursing

<sup>1</sup>Faculty of Science, Medicine and Health, University of Wollongong, NSW, Australia.  
Email: petermcl@uow.edu.au

<sup>2</sup>South Eastern Sydney Local Health District, Kogarah, Sydney, NSW, Australia.  
Email: mark.azer@health.nsw.gov.au

<sup>3</sup>Illawarra Shoalhaven Local Health District, Wollongong, NSW, Australia.  
Email: michael.watts@health.nsw.gov.au; erin.tuala@health.nsw.gov.au;  
kate.curtis1@health.nsw.gov.au

<sup>4</sup>Faculty of Medicine and Health, University of Sydney, NSW, Australia.

<sup>5</sup>Illawarra Health and Medical Research Institute, Keiraville, NSW, Australia.

<sup>6</sup>Present address: South Eastern Sydney Local Health District, Kogarah, Sydney, NSW, Australia.

<sup>7</sup>Corresponding author. Email: kirollos.nassief@health.nsw.gov.au

## Abstract.

**Objective.** The aim of this study was to determine factors related to emergency department (ED) care causing in-patient deterioration.

**Methods.** This retrospective cohort study examined in-patient records using the human factors classification framework for patient safety in a regional health service in New South Wales, Australia, between March 2016 and February 2017. Deterioration was defined as either the initiation of a medical emergency team call, cardiac arrest or unplanned admission to the intensive care unit.

**Results.** Of the 1074 patients who deteriorated within 72 hours of admission via the ED, the care received in the ED was a contributing factor for 101 patients (9%). The most common human causal factors were poor communication between staff, medical management errors, delayed treatment, medical documentation errors, nursing management errors and unclear policies or guidelines. Communication issues occurred the most when patients had more comorbidities ( $P = 0.039$ ) and were more likely to occur in the presence of a medical documentation error (odds ratio 4.4; 95% confidence interval 1.7–11.3). Unclear policies or guidelines as a factor was most frequent with a surgical diagnosis (34.5% vs 15.7% for surgical vs medical, respectively;  $P = 0.038$ ) and in patients  $\geq 80$  years of age (30.0% vs 21.8% for age  $\geq 80$  vs  $< 80$  years, respectively;  $P = 0.027$ ).

**Conclusion.** Quality monitoring and interventions that consider human factors are required to address preventable in-patient deterioration.

**What is known about the topic?** The ED represents the hospital's point of contact for potentially life-threatening conditions. Adverse event rates for emergency admissions are more than double those of non-emergency admissions. Patients are at particular risk of deterioration on discharge from the ED to the ward in the first 72 hours. Predicting which patients will deteriorate following transfer to the ward remains challenging, with care in the ED hypothesised to play a role.

**What does this paper add?** This paper reveals that in-patient deterioration relating to ED care could be reduced through the routine identification of causal factors within a human factors framework in any patient deterioration event and subsequent evidence-informed interventions to address these factors. It is also extrapolated that the implementation of any intervention should be informed by behaviour-change principles.

**What are the implications for practitioners?** It is implied that there is a need for the clarification and revision of policies and guidelines pertaining to the management of elderly patients, education regarding the critical importance of the often clinically masked vital sign deviations in younger patients and improved communication between staff, especially regarding patients with more comorbidities. Reviews of adverse events, such as patient deterioration, should incorporate a human factors analysis. Regular collation of data following adverse events should occur, with interventions considering all aspects of the factors that led to the event.

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## Introduction

The emergency department (ED) plays a crucial role for its surrounding community, being the first point of contact for often serious and life-threatening conditions. Australia's 287 EDs treated more than 8.4 million patients in 2018–19, or 23 000 patients per day, a 4.2% increase compared with 2017–18.<sup>1</sup> Patients generally have undiagnosed conditions and varying degrees of clinical urgency and severity.<sup>2</sup>

In 2018, the Australian Institute of Health and Welfare reported that adverse event rates for emergency admissions were more than double those of non-emergency admissions.<sup>3</sup> An adverse event is any incident, contributed to by medical care or the absence thereof, resulting in unintended patient harm. Avoidable clinical deterioration is considered an adverse event.<sup>4</sup> These avoidable lapses in safety and quality have substantial costs in terms of people's lives and hospital finances.<sup>5</sup> Considine and Currey found that 55.3% of patients who deteriorated and required a medical emergency team (MET) call were first admitted from the ED.<sup>6</sup> This and other recent work have demonstrated that a large proportion of these patients experience deterioration within the first 72 hours after admission onto the ward, and that deterioration occurs at higher rates for those with comorbid cardiac disease, diabetes or malignancy.<sup>7,8</sup> Lambe *et al.* reported that just one abnormal vital sign in ED was a strong predictor of deterioration.<sup>9</sup> However, the specific causes of patient deterioration and the indications for escalation to a rapid response were not assessed in that study.

Human factors may also be predictive of deterioration, adding complexity to the prevention and/or detection of deteriorating patients. Inadequate ED documentation or errors therein can lead to misdiagnosis, alongside miscommunication between staff, and further decrease the chances of detecting patient deterioration.<sup>10,11</sup> Institutional pressures to reduce ED lengths of stay to 4 h can lead to premature ward transfer. Given the limitations of a general medical/surgical ward in caring for a patient without a comprehensive and completed treatment plan, this may compromise patient safety.<sup>12,13</sup> Medical equipment is another factor to consider, whereby desensitisation and alarm fatigue may set in, allowing for the early stages of deterioration to go unchecked.<sup>14,15</sup>

The evidence around causal factors for patient deterioration following admission to the ward setting is limited, particularly in relation to the care provided in the ED. By determining these factors, a strategy to inform change and potentially prevent further preventable deterioration episodes could be developed.

The aim of this study was to identify ED-related causal factors for in-patient deterioration events following ED

discharge and, in particular, to determine whether factors such as communication between staff, delayed treatment and documentation errors increased risk.

## Methods

### *Setting and sample*

This was a retrospective cohort study conducted at two sites in a regional health service between March 2016 and February 2017. Ethics approval was obtained from the University of Wollongong and Illawarra Shoalhaven Local Health District Health and Medical Human Research Ethics Committee (LNR/16/WGONG/249).

### *Patient identification and data sources*

Patients who had been admitted to one of the study sites via the ED and had a deterioration event within 72 hours of admission from the ED were eligible for inclusion in this study. A deterioration event was defined as a MET call, a cardiac arrest call or an unplanned admission to the intensive care unit (ICU). Data were obtained from two sources: the site MET call databases and the electronic medical record. The site MET call databases were used to identify patients who deteriorated once they had left the ED. Both sites in the regional health service employ a clinical nurse consultant (CNC) to identify and audit all patients who receive a cardiac arrest call, an unplanned admission to the ICU or a MET call. Staff activate MET calls when they are concerned patient deterioration needs immediate medical review by the MET team.

Once patients who had a deterioration event within 72 hours were identified, additional data were collected by the CNC from the electronic medical records and entered into a purpose-built database. These data included over 100 event details across eight key sections. The key sections included patient factors (e.g. pre-existing conditions, calculated using the Charlson comorbidity index (CCI)<sup>16</sup>), admission diagnosis, vital signs at the time of the deterioration call, specific services involved in care delivery, factors contributing to the care delivery problem (including equipment, work environment, staff action and organisational factors) and patient outcomes.

### *Classification of causal factors*

The human factors classification framework for patient safety was used to collect human factors thought to play a role in leading to the patient deterioration adverse event to identify influencing or causal factors.<sup>17</sup> This included information that may have influenced clinical practice, such as regarding equipment, work environment, staff action and patient, organisational, individual and other factors.<sup>18</sup> This framework was

**Table 1. Factors contributing to the care delivery problem**

Domain	Description
1. Equipment	Events that involved subcategories of equipment or device failures, breakages or malfunctions, lack of medical equipment and medical supplies
2. Work environment	Events resulting from the location of the incident that could not have been changed by personnel at the time, including lighting, temperature, noise and physical layout
3. Staff action/communication	Referred to as staff action events; these resulted from direct involvement by a staff member, including subcategories of communication failures and documentation issues, medical task failures, problems monitoring a patient's status, delays in patient treatment, misdiagnosis of a patient's health condition and medication-related issues
4. Patient	Events resulting from direct involvement by a patient that influenced the events
5. Organisational factors	Organisational aspects that directly or indirectly influenced the safety and quality of medical and nursing activities and their management, including work practices, policies or guidelines, supervision, available resources (including staffing and equipment), work pressure and other organisational factors
6. Individual factors	Characteristics of staff members, including knowledge and skills, experience, stress, fatigue and other individual factors
7. Other	Additional events not classified elsewhere

adopted because previous inter-rater reliability for human factors classifications has been demonstrated to be high,<sup>19</sup> and the approach was based on James Reason's model of organisational incidents.<sup>20</sup> Each causal factor was classified into one of seven categories (Table 1), then several subcategories (Table 2).

These data were collected and classified by three nurse consultants (MW, ET, KC) with expertise in clinical case peer review, current critical care, ED and coronary care experience, as well as on cardiac arrest teams. These nurse consultants reviewed patients' clinical notes to identify any human causal factors contributing to deterioration. A data dictionary was developed in consultation with the nurse auditors (Table 2). In applying this, a single deterioration event was potentially attributed to one or multiple causal factors, as appropriate. To ensure consistency, where a causal factor did not neatly fit a single framework subcategory, a group decision was made and recorded.

For a deterioration event to be labelled as related to care received while in the ED, the causal factors identified must have had a clear relationship with or clearly contributed to the deterioration event. Examples of ED-related causal factors included a delay to intravenous antibiotics in a septic patient, missed diagnostic information (e.g. arterial blood gas in a deteriorating respiratory patient) or progressive deterioration in the ED with no identification or escalation. In contrast, if on Day 2 of admission the patient had a MET call for a postoperative complication, and it was clear the event had no link to the treatment and care provided within the ED, it would not be considered ED related.

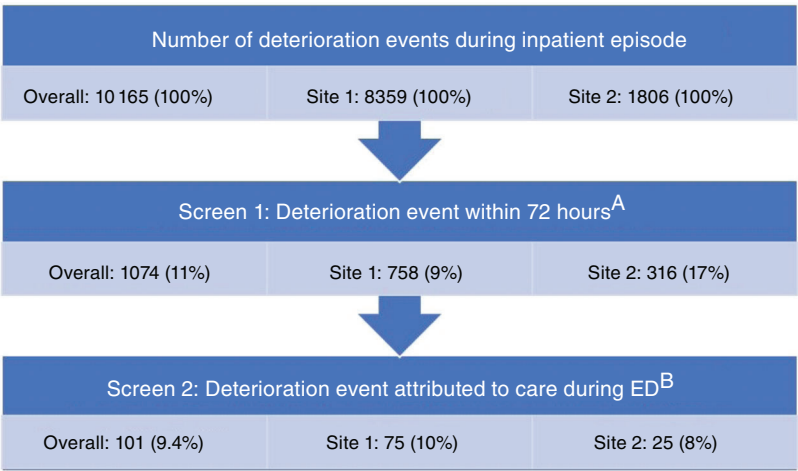
### Data analysis

Descriptive statistics were obtained for continuous data, including age, time to MET call, length of stay in the ED and CCI score. When normality was not demonstrated through either the Kolmogorov–Smirnov or Shapiro–Wilk tests, data were summarised as the median and interquartile range (IQR). Categorical data, including sex, hospital site, admission diagnosis, call type, death following event, time of admission and age group, are presented as frequencies and percentages of their respective totals.

Those human causal factors that had been linked to the deterioration of at least 20% of study participants were then

**Table 2. Classification framework subcategories for the identification of human causal factors of deterioration**

Equipment
Lack of medical equipment
Medical equipment breakage or failure
Medical supplies
Work environment
Work environment unclassified
Staff action/communication
Insufficient senior medical input
Insufficient consulting team input
Conflicting medical opinions
Poor communication between staff
Poor communication with patient
Poor medical documentation
Poor nursing documentation
Unclear limitations of care
Medical management error
Nursing management error
Failure to escalate
Red flags missed
Infrequent monitoring of vital signs
Infrequent monitoring of blood results
Infrequent monitoring unclassified
Delay in diagnosis
Delay in treatment
Delayed recognition of sepsis
Delay to transfer
Misdiagnosis
Staff action/communication unclassified
Patient
Patient unclassified
Organisational factors
Work practice related
Policy/guideline not followed
Policy/guideline unclear
Individual factors
Staffing issues
Staff training
Staff experience
Staff fatigue
Staff stress
Other
Other unclassified



**Fig. 1.** Selection and screening process for study participants. <sup>A</sup>Percentages calculated by dividing the numbers in Screen 1 by the total number of deterioration events. <sup>B</sup>Percentages calculated by dividing the numbers in Screen 2 by the numbers in Screen 1.

incorporated into the assessment of secondary outcomes, including the relationship between such factors and patient age group, admission diagnosis, mortality at event, time of admission and CCI score. These analyses were performed using the Chi-squared test, Fisher’s exact test, Kendall’s tau-b and linear regression.

All statistical analyses were performed in SPSS version 25 (IBM Corp.).

**Results**

There were 10 165 patients identified as having a deterioration event over the period 1 March 2016–28 February 2017. Of these, 1074 patients deteriorated within 72 hours of admission to the ward, and 101 of these events were attributed in some way to care during the ED stay (Fig. 1).

*Patient characteristics*

The median age of patients was 75 years (IQR 57–85 years), and most were male (55.4%; Table 3). Increasing age was associated with a higher CCI score ( $P < 0.001$ ). Most patients had a medical admission diagnosis (70.7%) rather than surgical. The median ED length of stay was 9.75 h (IQR 5.41–16.79 h).

*Human causal factors of patient deterioration attributed to care while in the ED*

As shown in Fig. 2, the most frequent human causal factors contributing to a deterioration event were poor communication between staff (35.6%;  $n = 36$ ), medical management error (29.7%;  $n = 30$ ), delayed treatment (28.7%;  $n = 29$ ), medical documentation error (25.7%;  $n = 26$ ), nursing management error (23.8%;  $n = 24$ ) and unclear policies or guidelines (21.8%;  $n = 22$ ). No individual human causal factor was associated with mortality at the deterioration event or with time of admission (Table 4). A relationship was demonstrated between the causal factor of poor staff–patient communication and a higher CCI score ( $P = 0.039$ ), and poor communication between staff was fourfold more likely to occur in the presence of a medical

**Table 3. Characteristics of the study participants ( $n = 101$ )**  
Data are presented as the median [interquartile range] or  $n$  (%). CA, cardiac arrest; MET, medical emergency team

Age (years)	75 [57–85]
Time to call (h)	19.47 [7.18–35.83]
Time of admission	
Day shift (0800–1600 hours)	32 (31.7)
Evening shift (1600–2400 hours)	42 (41.6)
Night shift (0000–0800 hours)	27 (26.7)
Length of ED stay (h)	9.75 [5.41–16.79]
CCI score	4.00 [2.50–6.00]
Sex	
Male	56 (55.4)
Female	45 (44.6)
Site	
Site 1	76 (75.2)
Site 2	25 (24.8)
Call type	
CA	10 (9.9)
MET Tier 2	72 (71.3)
Unplanned ICU admission	19 (18.8)
Admission diagnosis	
Surgical	29 (29.3)
Medical	70 (70.7)
Died at event	
Yes	6 (5.9)
No	95 (94.1)

documentation error (odds ratio (OR) 4.4; 95% confidence interval (CI) 1.7–11.3).

Medical management errors were associated with delayed treatment (OR 3.3; 95% CI 1.3–8.2), medical documentation errors (OR 2.7; 95% CI 1.1–6.9) and nursing management errors (OR 3.3; 95% CI 1.3–8.5). Unclear policies or guidelines as a factor was most frequent in patients aged  $\geq 80$  than  $< 80$  years (30.0% vs 21.8%, respectively;  $P = 0.027$ ), and with a surgical rather than medical diagnosis (34.5% vs 15.7%, respectively;  $P = 0.04$ ).

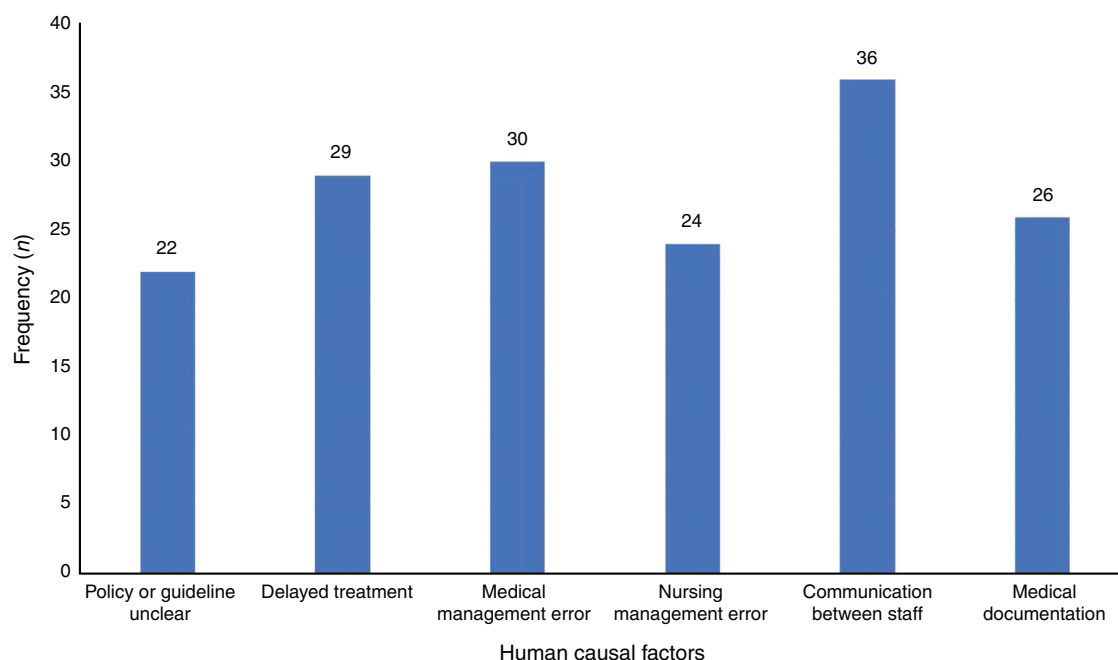


Fig. 2. Frequencies of the most common human causal factors relating to deterioration attributed to ED care.

The all-factor run of a linear regression with age yielded significant results for medical management error ( $P = 0.045$ ) and inadequate monitoring of observations ( $P = 0.002$ ). Inadequate monitoring of observations, despite not being one of the most frequent human causal factors shown in Fig. 2, was identified as an issue in seven deterioration events (6.93%).

## Discussion

This study found that human factors contribute to patient deterioration events in the first 72 hours of admission from the ED that can be attributed to care while in the ED. Of the six human factors that were the focus of this study, poor communication between staff was the leading cause of deterioration, which was heightened when the patient had multiple comorbidities. This is consistent with other literature,<sup>21</sup> which describes a reluctance to call for the help of a senior because of the need to persuade them regarding the need for their input and fear of being thought of poorly for an incorrect judgement. Institution-wide education in communication skills focusing on increased adherence to the ISBAR (Introduction, Situation, Background, Assessment, Recommendation) framework would help circumvent this issue.<sup>22</sup>

The impact of human causal factors on deterioration among elderly patients was highlighted in this study, especially as a result of an unclear policy or guideline. There are several possible explanations for this, including that the increased comorbidities that an elderly patient presents with may cause ambiguity in the interpretation of policies or guidelines that would normally be more straightforward for less complex patients.

Medical documentation errors of inadequacy, inaccuracy and omission, including those that led to communication issues and management faults, were associated with deterioration in 25.7%

of patients, and issues relating to monitoring of observations were identified in 6.93% of patients, particularly among younger patients. An explanation for the lack of monitoring of vital signs could be that the monitoring is occurring but not being documented due to time constraints and pressure to multitask in the resuscitation context.<sup>23</sup> A solution would be the introduction of automated downloading of vital signs from the monitoring systems to the electronic medical record in the ED, similar to the processes used in ICUs around Australia.<sup>24</sup> The documentation of vital signs becomes less vulnerable to omission of data and transcription errors through automated vital signs documentation systems, as opposed to manual documentation, with a 75% reduction in error prevalence.<sup>25</sup>

The power of this study could have been enhanced with a greater sample size, minimising the chance of Type II error. The study also did not contain a control group of patients who did not deteriorate. Although this would not have proven causality, it would have provided information on which human factors were more directly associated with the precipitating event of patient deterioration. Furthermore, the retrospective nature of the study and its dependence on medical record review inherently predispose to information and misclassification biases.

However, the risk of bias was extensively minimised through the peer review of data classification and screening by three independent auditors with broad experience in clinical case reviews, as well as clinical experience in critical care and coronary care units. A data dictionary of error classification was also composed to ensure consistency across the auditors regarding group decisions made on error classifications. Moreover, this is the first study of its kind to assess the role of human factors in the deterioration of patients on the ward following ED discharge.

**Table 4. Relationship between the most common human causal factors relating to deterioration attributed to ED care and various patient characteristics (age group, admission diagnosis, mortality at event and time of admission)**

Values show the percentage of deterioration events in which the human factor was present. Age group and time of admission *P*-values are from Kendall's tau-b; admission diagnosis *P*-values are from Pearson's Chi-squared test; admission diagnosis *P*-values are from Fisher's exact test

Human factor	Age group (years)				Admission diagnosis			Mortality at event		Time of admission						
	<50 (n = 19)	50–59 (n = 9)	60–69 (n = 16)	70–79 (n = 17)	≥80 (n = 40)	P-value	Medical (n = 72)	Surgical (n = 29)	P-value	Died (n = 6)	Survived (n = 95)	P-value	Daytime (n = 32)	Evening (n = 42)	Night (n = 27)	P-value
Poor communication between staff	42.11	10.53	18.75	35.29	42.50	0.449	38.57	31.03	0.478	50.00	34.74	0.663	37.50	40.48	25.93	0.379
Medical management error	36.84	0.00	6.25	35.29	40.00	0.139	27.14	34.48	0.465	33.33	29.47	1.000	34.38	23.81	33.33	0.869
Delayed treatment	31.58	33.33	12.50	23.53	35.00	0.552	32.86	20.69	0.226	33.33	28.42	1.000	18.75	35.71	29.63	0.283
Medical documentation error	36.84	22.22	18.75	17.65	27.50	0.742	28.57	17.24	0.238	33.33	25.26	0.646	28.13	26.19	22.22	0.608
Nursing management error	36.84	22.22	12.50	35.29	17.50	0.235	21.43	31.03	0.310	0.00	25.26	0.331	18.75	23.81	29.63	0.328
Unclear policies or guidelines	5.26	22.22	18.75	23.53	30.00	0.027	15.71	34.48	0.038	0.00	23.16	0.335	28.13	16.67	22.22	0.553

## Conclusion

Human factors that contribute most to episodes of patient deterioration include poor communication between staff, medical management errors, delayed treatment, medical documentation errors, nursing management errors and unclear policies or guidelines. Communication issues are more likely in the presence of a medical documentation error and in the context of patients with many comorbidities. It is recommended that reviews of adverse events, such as patient deterioration, should incorporate a human factors analysis. These data should be regularly collated to ensure all factors contributing to adverse events are constantly informing any corrective interventions.

## Data availability

The data that support this study cannot be publicly shared due to ethical or privacy reasons and may be shared upon reasonable request to the corresponding author if appropriate.

## Competing interests

The authors declare that they have no competing interests.

## Declaration of funding

This research did not receive any specific funding.

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