

## A description of events associated with scene response by helicopter based medical retrieval teams

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Accepted 18 December 2002

### Abstract

The critical incident technique, used in critical care related medical specialities as a quality tool, may be applicable for evaluation of pre hospital care for injured patients. This study describes events documented by medically staffed retrieval teams that occurred during a scene response. Incidents were defined as events, which may have or did reduce the safety margin for the patient and/or retrieval team. Positive events were defined as events that actually did, or had the potential to, positively influence the outcome for the patient and/or retrieval team task.

257 patient transport records had documented events (216 incidents, 41 positive), 35.6% had multiple events. Doctor's experience correlated with event documentation,  $R^2 = 0.614$  ( $P < 0.0001$ ). Incidents occurred mostly during team dispatch, prior to arrival and whilst team was at the scene. Equipment related incidents accounted for 24.3% of incidents. Winch incidents accounted for 12% of equipment incidents. Environmental factors were associated with 14.3% of incidents.

In conclusion, the description of events associated with a scene response can be used for quality evaluation. Incidents and positive events should be evaluated. Future evaluation can benefit by incorporating detailed information from a broader cross-section of retrieval organisations.

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### 1. Introduction

Emergency medical services (EMS), provide a variety of platforms for out of hospital transportation of critically ill patients. These may be from the scene of an accident or transfer of patients from one medical facility to another. They may differ in terms of tasking, crew composition and associated skill level, transport vehicle used, operating environments and patient case mix. Such services have escalated since the late 1970s, despite an ongoing debate as to their clinical effectiveness [3–6,12,14,16,19].

Samuel Franklin Cody, an aviation pioneer, publicly demonstrated the principles of aeromedical evacuation on 14 July 1913 in the United Kingdom. During a steep ascent the stretcher, to which a healthy volunteer had been strapped, began to slip towards the pusher propeller. Fortunately for the patient, his cries for help alerted Cody to this event and Cody managed to alter direction and land the plane without further incident. The next day the local media documented what may be aviation medicine's first patient incident report [13].

The early 1980s saw a peak in aeromedical EMS accident rates of nearly 25 accidents/100,000 flight hours [9]. During that same period, service evaluation through retrospective clinical case audits documented significant, in transit, adverse patient physiological effects that were attributed to the level of transport service provision [8,18,21]. Guidelines for the transportation of critically ill patients have since been developed [1,2,10].

The critical incident technique was first used to reduce the loss of life of military pilots and aircraft during training [11]. It has subsequently been applied to areas of medicine closely aligned with the clinical spectrum of out of hospital patient transportation [7,22,25]. Thus the highly complex and unpredictable environment in which patient transportation occurs, may also lend itself to evaluation from such a quality tool.

The purpose of this study was to describe events documented by physician staffed retrieval teams called to treat and transport injured patients from the scene of an accident.

### 2. Materials and methods

The NRMA CareFlight New South Wales Medical Retrieval Service is based at Westmead, Sydney, Australia. It

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provides a 24-h physician/paramedic retrieval team for scene and interhospital missions utilising helicopter with winch capability, road and fixed wing vehicles. Teams are capable of advanced life support, minor surgical procedures and administration of blood products. Monitoring includes invasive and non-invasive pressure recording, ECG, pulse oximetry, capnography and temperature. The physicians are of a senior level, being advanced trainees or qualified specialists in emergency medicine, anaesthesia or intensive care. Team paramedics are trained for advanced life support, water and high angle rescue and vehicle extrication. Both, physician and paramedical staff are trained in helicopter winch rescue procedures.

A paper and electronic transport medical record is completed for each patient. As part of the organisational continuous quality management program attending medical staff are asked to voluntarily document, in a non-structured free text format, aspects of the mission that they considered to have impacted upon mission outcome.

A retrospective review of records for scene missions from December 1990 to November 2001 was conducted. Records with documented events were selected. An event was defined as something that happens to or with a person. Events were further classified as an incident or a positive event. An incident was a clearly documented event that may have or did reduce the safety margin for the patient and/or retrieval team. A positive event was a clearly documented event that may have or did, positively influence the outcome for the patient and/or retrieval team mission. Missions that involved retrieval team training and for which there was no patient contact were not included.

Retrieved records were de-identified for patient and crew details. Events were classified according to:

- stage of retrieval;
- equipment related;
- communication (clinical and mission orientated);
- procedural (clinical and mission orientated);
- delays in the delivery of patient treatment or in-patient access;
- differences in opinion with non-retrieval staff;
- misdiagnosis;
- interaction with other emergency services;
- retrieval team expertise;

- environmental factors;
- aircraft availability.

Task and clinical demographic features specific for each scene response were also included. Trauma Injury Severity Scores were available for some patients only.

Descriptive statistics were used to analyse continuous variables and comparison of nominal data was performed using  $\chi^2$  analysis. Level of significance was taken as 0.05. Statistical analysis was performed using Minitab versus 12 (Minitab Inc.) statistical software.

### 3. Results

Over the study period, there were 1198 records of scene missions, 257 of which had documented events (216 incidents, 41 positive). More than one event was documented in 35.6% patient records. During the study period, scene missions involved 80 different physicians, 59 (73.8%) of whom had documented an event. The median and range of reported incidents for each physician was 3 (1–5) and 2 (1–3) for positive events. The number of documented events per physician correlated with the physician's retrieval experience  $R^2 = 0.614$  ( $P < 0.0001$ ). Physicians who documented events, participated in a mean of  $14.2 \pm 13.2$  missions as compared to  $4.3 \pm 3.1$  missions for physicians who did not document an event,  $P < 0.0001$ .

Patient and mission demographics are shown in Table 1. Patients with documented events had physiological parameters suggestive of a higher severity of injury, more likely to be intubated and longer retrieval team scene time. Mean Injury Severity Score (ISS) was  $29.5 \pm 15.4$ . Helicopter transport was involved in 97% of missions, of which, 21% involved a winch operation.

Fig. 1 shows incidents and positive events by stage of mission. Fig. 2 shows the nature of incidents. Incidents that occurred from time of retrieval team tasking, but prior to team scene arrival, were predominately those resulting in a delay to patient treatment, difficulty in obtaining clinical information and equipment misplacement and/or failure. Delays in vehicle availability accounted for 6.5% of all incidents. The most frequently documented incidents following retrieval team arrival and whilst in transit to the receiving hospital

Table 1

Parameter	Documented events ( $N = 257$ )	No documented events ( $N = 1198$ )	<i>P</i> -value
Male (%)	64.8	68.8	0.0001
Age	$34.8 \pm 15.9$	$32.9 \pm 15.7$	0.07
Systolic blood pressure (mmHg)	$114 \pm 31$	$121 \pm 29$	0.08
Heart rate	$97 \pm 26$	$92 \pm 22$	0.014
Glasgow Coma score	$12.5 \pm 4.1$ (median = 15)	$13.1 \pm 4$ (median = 15)	0.02
Time of day (24 h)	1450	1416	0.58
Scene patient contact time (min)	37	30	0.0005
Tracheal intubation (%)	23.7	10.8	<0.0001

### Stage of mission and documented events

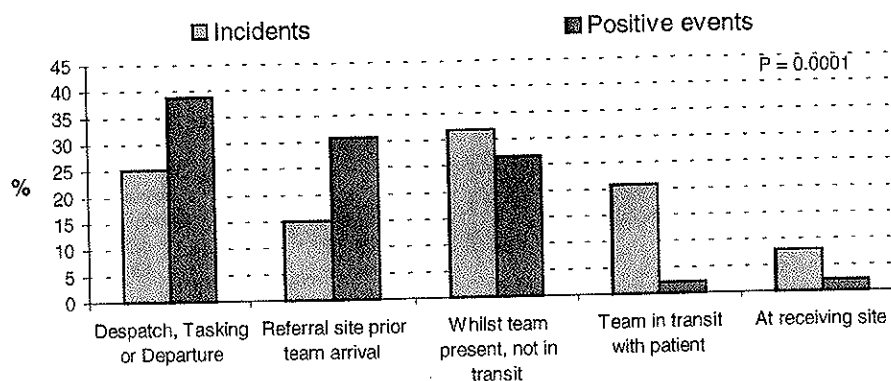


Fig. 1.

### Nature of documented incidents

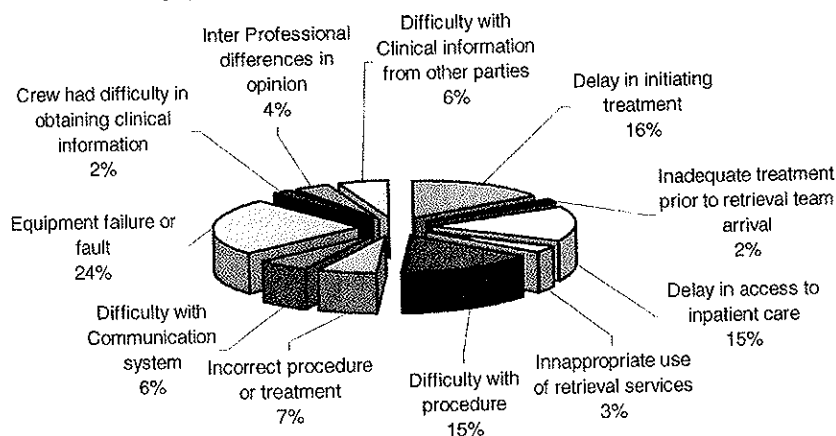


Fig. 2.

were, equipment incidents, procedural difficulties, delays in initiating treatment, related to communication and communication systems and due to environmental factors. Delays in obtaining in-patient access, difficulty with communication and differences in opinion with non-retrieval staff were mostly documented after arrival at the receiving hospital.

Equipment incidents accounted for 24.3% of all incidents. Table 2 illustrates their nature and frequency. The category of monitor failure related to documented problems with non-invasive measurement of blood pressure (42%), pulse oximetry (54%) and ECG (4%). The majority (82%) of all equipment related incidents occurred whilst the retrieval team was present and in transit to the receiving hospital, whilst 13% occurred during tasking and preparation for departure to the scene and 5% at the receiving hospital. Winch associated incidents accounted for 12.3% of equipment incidents. These were as a result of failure to follow, or difficulty with, correct winch procedures, environmental factors and one occasion of winch mechanical failure. Overall environmental and scene physical factors contributed to 14.3% of all incidents.

Fig. 3 illustrates the positive events for each mission stage. Organisational factors and timeliness of response predominated during tasking. Patient treatment prior to retrieval team arrival, interaction amongst the different EMS and retrieval

Table 2

Nature of equipment incidents ( <i>N</i> = 52)	Percentage (%)
Monitor equipment failure	19.3
Forgotten/missing	12.3
Winch related	12.3
Monitor power failure	10.5
Road vehicle fault	8.8
Radio fault	7.0
Stretcher fault	7.0
Airway disconnect	5.3
Equipment damaged	5.3
Drug error	3.5
IV dislodged	3.5
Oxygen source	1.8
Helicopter damaged	1.8
Blood product damaged	1.8

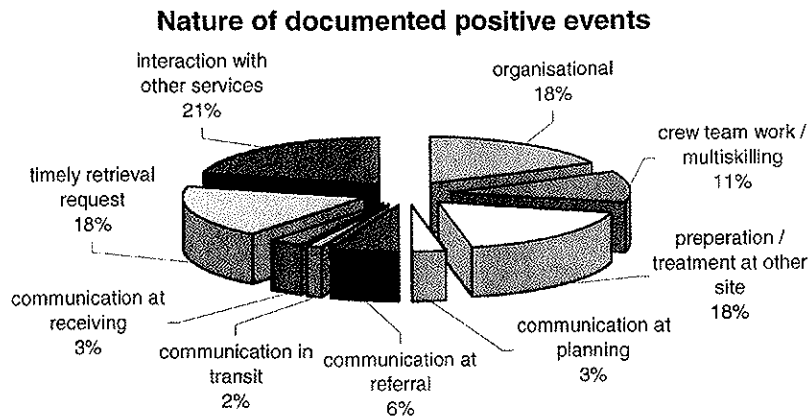


Fig. 3.

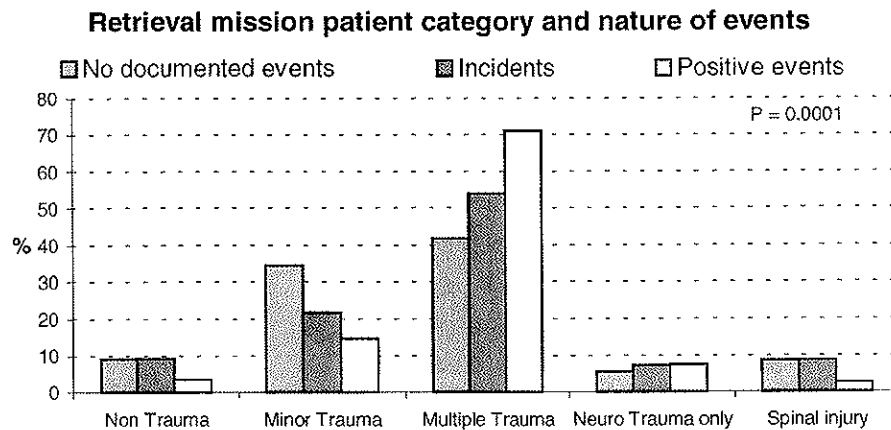


Fig. 4.

team multi skilling (i.e. non-patient management retrieval team skills) predominated during retrieval team scene presence.

Figs. 4 and 5 illustrate the type of event, patient diagnostic categories and need for medical presence. The attending retrieval team physician determined the need for a

medical presence. When compared to patients with minor injuries, patients with multiple trauma and/or neurological injury were more likely to have documented events. Patients who received medical specific interventions (e.g. drug assisted tracheal intubation, multiple interventions, diagnostic skills) and medical skills that exceeded ambulance protocols

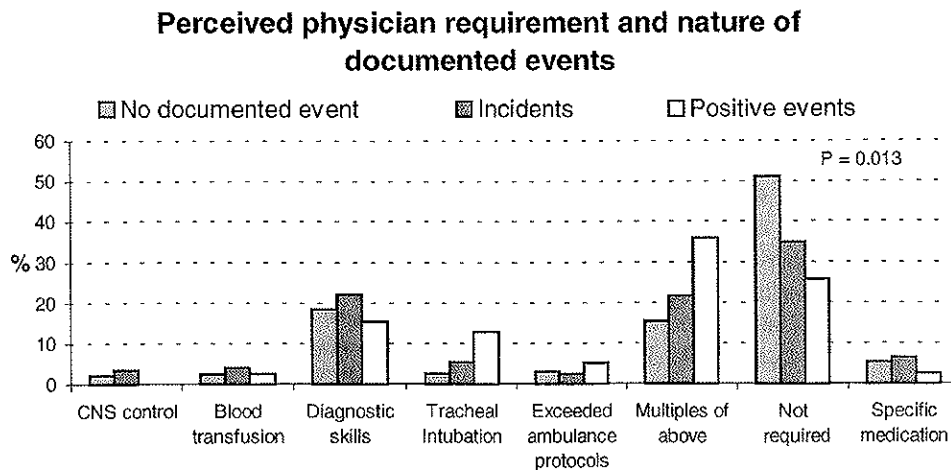


Fig. 5.

were more likely to have documented events, especially positive ones.

#### 4. Discussion

This study described scene events documented by attending physician retrieval team members. Most incidents occurred at the scene and at time of retrieval team tasking and were associated with delays in the performance of patient treatment, access to in hospital patient care, equipment and communication related problems. Positive events occurred at retrieval team tasking, prior to and at time of team scene presence. They were associated with timeliness of retrieval team tasking, prior treatment by other EMS, retrieval team multi skilling, performance of multiple patient interventions, interaction with other services and team organisational factors. Such information has implications for future quality improvement of EMS response for pre hospital response.

Events, especially positive ones, were mostly documented for patients who had multiple and/or head trauma, a greater physiological disturbance, need for drug assisted tracheal intubation, multiple interventions, diagnostic and medical skills that exceeded ambulance protocols. This may indicate that events were more likely to be considered significant, and thus documented by physicians, for patients with a higher severity of illness and/or requiring a greater level of intervention or with a higher probability of actual or potential patient risk.

The retrieval physician-patient scene contact time was longer for patients with documented events and may reflect a direct impact of incidents on retrieval team scene time. This time, on average of 7 min, could be considered clinically significant, especially as it was also associated with patients with a greater physiological disturbance. The performance of scene procedures by medical staff however is not always associated with an increased scene time when compared to the scene time of ambulance officers [3,5].

Equipment incidents were reported for 24.3% of incidents. Equipment failure, damage to equipment, forgotten, missing and power failure were the most frequent. This incidence of equipment failure is almost three times that of reported anaesthetic related equipment incidents [23]. This may be due to the impact of the harsher pre hospital environment, the pre hospital use of anaesthetic related equipment, otherwise developed for a hospital environment, differences in the frequency of equipment utilisation pre hospital as compared to hospital and differences in patient severity of illness. For the latter, the clinical utility of some monitors, e.g. pulse oximetry, is affected by the presence of hypoperfusion [15,24].

The utility of the incident monitoring methodology as a quality tool for the medical response component to a scene mission is suggested by this study. Almost 75% of doctors documented events that pertained to patient and/or team safety. Organisational factors related to the NRMA

CareFlight's quality activities would have influenced the participation rate and type of event documentation. This study also showed that doctor experience and patient severity of injury does influence the rate of event documentation.

This study also examined positive events, that is events documented to, or had the potential to, result in a positive impact upon patient outcome or retrieval team task. The examination of positive events as a quality tool has been previously utilised for nuclear aircraft carriers, air traffic control and nuclear power plants [20]. In this study, positive events were less frequently reported but appeared to mirror incidents. When the two are combined, they can indicate areas of actual (positive events) and potential (incidents) improvement. Positive events may describe successful strategies and thus provide a basis for their future incorporation into strategies for incident management. Information from this study points towards the benefits of early identification of the need for, and tasking of, physician staffed retrieval teams whose crew have been trained to perform skills other than those directly involved with patient management, have the capacity to interact with other services, and familiar with the required communication skills and systems.

Such information indicates a potential role for crew resource management (CRM) training within EMS services, as the one described in this study. CRM has been successfully used within the aviation environment. Comparisons with the aviation environment and that of the hospital critical care environment (operating theatre and intensive care) have been suggested and highlight crucial differences in their approach to incident management and team performance evaluation [17]. These differences relate to teamwork, vertical communication and recognition of stress and fatigue [17], factors that are not unfamiliar within EMS.

It has been suggested that safety systems aimed at reducing unwanted variability are less likely to succeed than high reliability systems that anticipate incidents and provide the resources for staff to recognise and manage errors [20]. Such systems accept human variability as a safeguard and aim to anticipate incidents and provide training in their recognition and management [20]. The out of hospital environment, being complex, unpredictable and dynamic may also favour such an approach. Future, more detailed analysis, including that of antecedents of events, may provide a stronger basis for such a strategy.

Limitations of this study are that it was retrospective, involved a single regional physician staffed retrieval service over a lengthy period of time. Event documentation by the team physicians did not follow a standard format, as is in keeping with incident monitoring methodology. Thus identification of antecedents, potential preventability and incident impact could not be reliably or consistently determined. Scene EMS response involving trauma patients have a multidisciplinary involvement and as such a broader contribution of information from non-physician scene or receiving hospital physician staff can potentially provide a broader contribution to scene related event identification.

## 5. Conclusion

In conclusion, this study provides a basis for the consideration of incident monitoring as a quality tool for the evaluation of the pre hospital response to injured patients by physician staffed retrieval teams. It identified incidents, positive events and the associated environmental factors. Such information would be useful for educational and quality activities, in particular for a system modelled upon high reliability organisations. A future, broader, systematic examination of events during scene response would enable a further evaluation of such events.

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