# Information Loss in Emergency Medical Services Handover of Trauma Patients

Alix J. E. Carter, MD, MPH, Kimberly A. Davis, MD, Leigh V. Evans, MD, David C. Cone, MD



Abstract

**Introduction.** Little is known about how effectively information is transferred from emergency medical services (EMS) personnel to clinicians in the emergency department receiving the patient. Information about prehospital events and findings can help ensure expedient and appropriate care. The trauma literature describes 16 prehospital data points that affect outcome and therefore should be included in the EMS report when applicable. **Objective.** To determine the degree to which information presented in the EMS trauma patient handover is degraded. **Methods.** At a level I trauma center, patients meeting criteria for the highest level of trauma team activation ("full trauma") were enrolled. As part of routine performance improvement, the physician leadership of the trauma program watched all available video-recorded full trauma responses, checking off whether the data points appropriate to the case were verbally "transmitted" by the EMS provider. Two EMS physicians then each independently reviewed the trauma team's chart notes for 50% of the sample (and a randomly selected 15% of the charts to assess agreement) and checked off whether the same elements were documented ("received") by the trauma team. The focus was on data elements that were "transmitted" but not "received." **Results.** In 96 patient handovers, a total of 473 elements were transmitted, of which 329 were received (69.6%). On the average chart, 72.9% of the transmitted items were received (95% confidence interval 69.0%–76.8%). The most commonly transmitted data elements were mechanism of injury (94 times), anatomic location of injury (81), and age (67). Prehospital hypotension was received in only 10 of the 28 times it was transmitted; prehospital Glasgow Coma Scale [GCS] score 10 of 22 times; and pulse rate 13 of 49 times.**Conclusions.** Even in the controlled setting of a single-patient handover with direct verbal contact between EMS providers and in-hospital clinicians, only 72.9% of the key prehospital data points that were transmitted by the EMS personnel were documented by the receiving hospital staff. Elements such as prehospital hypotension, GCS score, and other prehospital vital signs were often not recorded. Methods of "transmitting" and "receiving" data in trauma as well as all other patients need further scrutiny. **Key words:** emergency medical services; communication; patient transfer; process assessment (health care); interdisciplinary communication

PREHOSPITAL EMERGENCY CARE 2009;13:280–285

## Introduction

The handover of patients from one health care provider to another is recognized as a high-risk activity and carries the potential for loss of important information.[1–3] Little is known about how effectively information is transferred from emergency medical services (EMS) personnel to the clinicians in the emergency department (ED) receiving the patient. Information about prehospital events and clinical findings can help ensure expedient and appropriate care. Trauma patients are a reasonable subgroup to begin to evaluate the integrity of information transmission between EMS providers and receiving clinicians, as the trauma literature describes a set of prehospital data points that are known to have an impact on outcome and therefore should be included in the EMS report and known by the receiving team.[4–16] Using this established list of data points, this study sought to establish the baseline degree of information degradation during information transmission in a single-patient handover.

## Methods

### Study Design

A literature search was conducted in MEDLINE to determine the key prehospital data elements that have prognostic value and are therefore clinically important to receiving clinicians. The search strategy was "prehospital OR EMS OR ambulance" and outcome* and trauma and predict*. A final list of 16 key prehospital elements known to have an impact on patient outcome was derived and finalized in collaboration with the institution's trauma team (Table 1). Prehospital hypotension,[6,10,12,15] Glasgow Coma Scale (GCS) score,[4,5,8,14,15] patient age,[11] Injury Severity Score (ISS),[11] and Revised Trauma Score (RTS)[11,13] have

Received November 6, 2008, from the Department of Surgery, Section of Emergency Medicine (AJEC, LVE, DCC) and Section of Trauma, Surgical Critical Care and Surgical Emergencies (KAD), Yale University School of Medicine, New Haven, Connecticut. Revision received December 18, 2008; accepted for publication December 19, 2008.

Dr. Carter is currently at Nova Scotia Emergency Health Services, Dartmouth, Nova Scotia, and the Department of Emergency Medicine, Dalhousie University School of Medicine, Halifax, Nova Scotia, Canada.

Presented as a poster at the National Association of EMS Physicians annual meeting, Jacksonville, Florida, January 2009.

Address correspondence to: Dr. A. Carter, c/o Nova Scotia EHS, 239 Brownlow Avenue, Suite 200, Dartmouth NS B3B 2B2, Canada. e-mail: alix.carter@gov.ns.ca



doi: 10.1080/10903120802706260

TABLE 1. Key Data Elements in a Trauma Handover

| |
|---|
| Prehospital hypotension |
| GCS score |
| Patient age |
| End tidal $CO_2$ value |
| Pulse rate |
| Respiratory rate |
| Oxygen saturation |
| Blood loss in the field (quantity) |
| Death of an occupant in the same compartment |
| Mechanism of injury |
| Intrusion |
| Extrication time |
| Estimated crash speed |
| Anatomic location of injury |
| Preexisting disease |
| Prehospital intubation |

$CO_2$ = carbon dioxide; GCS = Glasgow Coma Scale.

TABLE 2. Criteria for Full Trauma Team Activation

| |
|---|
| Hemodynamic instability—systolic blood pressure <90 mmHg |
| Respiratory distress, need for intubation, or field intubation prior to arrival |
| Altered mental status—GCS score ≤8 |
| Any question of spinal injury, or patient with paresthesias and/or paralysis |
| Penetrating injury to the head, neck, or abdomen, including wounds to the buttocks |
| Patient with flail chest |
| Patient with crush injury to the body cavity proximal to the wrist or ankle |
| Patient with open body-cavity injuries or with evisceration of internal organs |
| Injuries above and below the diaphragm, e.g., clavicle fracture and femur fracture |
| Ejection from or by a moving vehicle (motorized or nonmotorized) |
| Urestrained occupant in a rollover collision |
| Electrical or thermal burns over >30% BSA |
| Amputation of a limb proximal to the wrist or ankle |
| Fall from a height >20 feet |
| Severe hypothermia in a trauma patient (core temperature <32°C/89.6°F) |
| Any two or more Modified Trauma Response criteria |
| Mechanism of injury or circumstances warranting trauma team evaluation |
| At the discretion of the emergency medicine or trauma surgery attending physician or the triage nurse |

BSA = body surface area; GCS = Glasgow Coma Scale.
Modified Trauma Responses represent a lower level of acuity, are not taped, and are not attended by a staff trauma surgeon; they are not included in this study.

been found in other studies to be important. Because the ISS and RTS are not calculated in the field, these were excluded. Anatomic location of injury as an individual data point was found in the literature to be predictive and was therefore retained.[7,11,15] In previously published assessment of the American College of Surgery field trauma triage criteria,[7,15] the most useful elements were anatomic and physiologic criteria, including location and mechanism of injury, GCS score, respiratory rate, and death of a same-car occupant, but not the crash speed or deformity. These elements were retained, along with extrication time, because of their high degree of fidelity and their inclusion criteria for local trauma activation for "full trauma" alerts as defined at our trauma center (Table 2). The use of end-tidal carbon dioxide ($CO_2$) monitoring[9]and oxygen saturation monitoring,[6]the presence of preexisting disease,[6] and significant intrusion[15] were retained, as supported by the literature.

Per protocol, as part of our institution's performance improvement process, all videotaped full trauma responses are reviewed by the physician leadership of the trauma program. This allows off-line detailed review of the handover and other aspects of the resuscitation. All ED charts, including trauma notes, are scanned and electronically preserved and could be reviewed independently from the videotape review.

## Population and Setting

The study was conducted at an urban, academic, level I trauma center that is American College of Surgeons verified and state Department of Health designated. The study population consisted of all patients aged 16 years and over meeting our institution's trauma triage criteria (Table 2) as requiring a "full trauma" response, and for whom videotaped documentation of all trauma bay events (from initial arrival to departure from the trauma bay) was available. Transfers from other hospitals were excluded, as there are multiple sources of prearrival information.

## Experimental Protocol

The videorecorder is activated as soon as the trauma team is notified of an incoming full trauma. The notification does not include prearrival information. The patient is brought directly to the trauma bay from the ambulance, and all information transmission occurs here. While conducting their routine tape review, the physician leaders of the trauma program (KAD, LVE) identified which of the 16 elements (as appropriate to the case) were verbally "transmitted" by the reporting EMS provider(s) to the members of the trauma team in attendance. Each physician completed a separate checklist, marking down whether each of the 16 elements had been "transmitted" or not. Any disparities identified in the two checklists were immediately discussed, and further review of the tape was performed to ensure 100% concordance between the two physicians.

Two EMS physicians (AJEC, DCC), blinded to the checklist findings, reviewed the ED chart notes and checked off whether the same elements had been documented ("received") by the trauma team on the ED chart. Each of these two physicians reviewed 50% of the sample, as well as a randomly selected 15% of the other physician's sample to allow for testing

of reliability of data extraction. Notes included the trauma housestaff and attending staff notes as well as the trauma nursing notes, but excluded notes from consulting services as they may not have received their information from the EMS handover. All full trauma responses are managed by an attending trauma surgeon, with the emergency physicians providing airway management. Finally, the lead investigator (AJEC) correlated the "transmitted" checklist to the "received" checklist for each patient.

The focus of the study was on identifying data elements that were "transmitted" (spoken by EMS) but not "received" (documented by the trauma team), not on evaluating how many elements ought to have been transmitted, since certain elements in this broad range of key prehospital data in the trauma population might not be applicable to certain patients.

## Analytical Methods

Data analysis was conducted in Microsoft Excel (Microsoft Corporation, Redmond, WA) and SAS version 9.1 (SAS Institute Inc., Cary, NC). The random sample of 15% of the ED charts for duplicate review was chosen using the SAS "survey select" function.

## Sample Size Determination

Because of the pilot observational nature of this study, we did not generate a priori hypotheses regarding the rates at which the data points are transmitted and received; rather, this study attempted to ascertain overall patterns regarding these data points. Accordingly, based on the nature of the data points being collected, the goal sample of roughly six months of data would provide a reasonable estimate of the ratios in which these data items are transmitted and received.

## Measurements

Results consist of the ratios of "received" to "transmitted" for each of the 16 required elements. Where applicable, 95% confidence intervals (CIs) are presented. Simple descriptive statistics for each element were also calculated. Rates of missing or untransmitted data were compared between elements.

## Human Subject Committee Review

This study was approved by the institution's human investigations committee. Requirement for consent was waived in this minimal-risk study. EMS providers and trauma team members were aware that trauma resuscitations were being taped for quality improvement, but did not know about this study.

# RESULTS

After excluding five interhospital transfers, there were 113 taped handovers evaluated during the study period from January 1, 2008, to June 30, 2008. This represented approximately 30% of the full trauma responses evaluated over the study period. Of these, 17 taped handovers were eliminated because the ED chart was unavailable, resulting in a final sample of 96 handovers. Characteristics of these 96 trauma patients, as well as the general trauma population seen at this institution, are presented in Table 3.

The mean number of data elements transmitted per handover was 4.90 (95% CI 4.55–5.24), and the median was 5. The maximum number of elements transmitted in a handover was 9, and the minimum was 1. The most commonly transmitted data elements were mechanism (94 times), anatomic location of injury (81), and age (67). Of a possible 1,536 data elements available for transmission (96 patients × 16 elements), a total of 473 were transmitted, of which 329 were received (69.6%). Of the 1,063 that were not transmitted, 483 were not applicable to the given case (e.g., "vehicle speed" in a fall victim), and 580 were applicable and likely should have been transmitted, but were not. This represents an interesting, but separate, question of how well the handover is executed. This study, however, focused on the receipt or loss of the information that was actually transmitted.

In the average handover, 72.9% of the items transmitted were received (95% CI 69.0%–76.8%), but the variability from one element to another was significant (range 33.3%–100%, median 75%). Information about prehospital hypotension was received in only 10 of the 28 times it was transmitted, prehospital GCS score 10 of 22 times, and pulse rate 13 of 49 times. The ratio of received to transmitted for each element is shown in Figure 1.

The kappa between the two authors extracting data from the trauma notes was 0.86, showing a high degree of association between the two raters.

# DISCUSSION

The handover of a patient from one provider to the next is recognized as a potential "error producing

TABLE 3. Characteristics of the Trauma Population

| | Study Sample | All Full Trauma Patients (January–June 2008) |
|---|---|---|
| Blunt | 86% | 83% |
| Penetrating | 13% | 15% |
| Burn | 1% | 2% |
| Admitted | 70% | 74% |
| Average ISS | 14 | 14 |
| Average RTS | 7 | 7 |

ISS = Injury Severity Score; RTS = Revised Trauma Score.

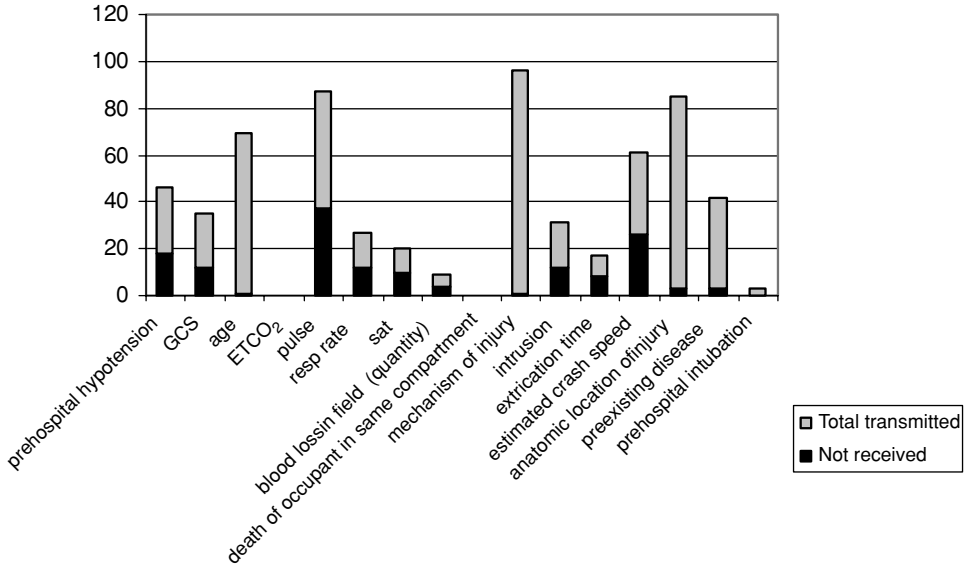


FIGURE 1. Ratio of data not received to total data transmitted. $ETCO_2$ = end-tidal carbon dioxide; GCS = Glasgow Coma Scale (score); resp = respiratory; sat = saturation.

condition."[1] The communication of information known by the first clinician or team to the second clinician or team is vital; the impact of insufficient or inaccurate data, poorly organized information, or the insertion of "pseudoinformation" and cognitive overload[1] cannot be overlooked, but has been poorly studied. Knowledge of what happened to the patient prior to his or her arrival in the ED can help ensure expedient and appropriate care. Stiell et al. coined the term "information gaps" to describe pieces of information the ED physician needed but found to be missing. They discovered that these information gaps led to longer ED lengths of stay, typically extending the time by one hour.[2] Though generalized from studies of in-hospital patient handovers, the data elements studied here represent pieces of information that are needed by the receiving physician, based on trauma literature and guidelines.[4–16] The failure to receive these data pieces will certainly produce information gaps and therefore potentially lead to increased lengths of stay, as well as impaired administration of appropriate and timely clinical care. Handover has also been documented to be one of the times of highest medicolegal risk in the in-hospital setting, and with the potential for loss of information that may not be available from any other source, the EMS-to-ED transfer represents another important time of patient handover.[3]

These data can be examined from the perspectives of both what was transmitted and what was received. We observe that of the 16 possible data elements, on average only 4.9 elements were transmitted at each handover. Of course, many elements would not be relevant to all trauma patients. For example, crash speed would not be part of the handover report of a gunshot wound victim. However, there were numerous instances of data points that likely should have been transmitted, but were not. For example, the patient's heart rate, a key vital sign, was transmitted in only 49 cases. Of the three prehospital intubations in the study sample, there was no transmission of the end-tidal $CO_2$ value. EMS protocols for the catchment area of our institution require the use of end-tidal $CO_2$ and the capture of a quantitative end-tidal $CO_2$ value for all intubated patients, whether trauma or nontrauma. It is unclear whether the lack of data transmission represents a failure to obtain the data in the field (an opportunity for EMS education and training) or merely a failure in data transmittal. If it is a failure in data transmission, this is consistent with previous literature, in which ambulance staff reported a lack of training in how to give a proper handover, and the receiving staff noted a lack of structure and uncertainty about which information was relevant.[17] There is also some disparity in the perceived quality of the report. Thakore and Morrison surveyed EMS providers and the receiving hospital staff and found that EMS providers were on the whole more satisfied with the quality of the handover than were the receiving staff.[17] Reasons for this are unclear and could include the fact that EMS providers transmit a more complete report than the one that is received. This would be consistent with our results. It is also possible that part of the EMS providers' satisfaction came from handing over a patient and becoming available for the next call, or the fact that EMS providers hold different expectations from ED staff. Prehospital providers also report a lack of satisfaction with how much attention is paid to their report.[18] This has multiple consequences; the receiving staff obtain less information from the report, and if the ambulance crew feel ignored or rushed, a shorter and less complete report might be given.

In addition to the potential to improve the content of the handover, there is the significant problem of the loss of information that *is* presented; this was the focus of our study. In an average handover, only 72.9% of the transmitted information was received and documented in the patient's permanent medical record, and this percentage varied widely depending on the element in question (Fig. 1). Mechanism of injury and age, for instance, were not only the most commonly transmitted, but also virtually always received. However, vital signs, such as GCS score, pulse rate, respiratory rate, and the presence of hypotension, were received at best half the time. These are known prognostic indicators in trauma.[4–16] Of note, credit was also given in this study if information was provided only when prompted by receiving trauma team staff; if a key element was either not reported or missed for whatever reason, the team had the opportunity to ask for it.

Essentially nothing is known about how well information is transferred from the paramedic or emergency medical technician (EMT) to the clinicians receiving the patient in the ED. This study attempted to establish a baseline proportion of information lost in a handover. Bruce and Suserud found that handovers were easier when the patient's clinical problem was clearly identifiable, and worse if the staff had other tasks to attend to or if the patient had a life-threatening condition.[19] This should make the present example of a trauma handover almost a "best-case" scenario, where the team is dedicated to listening to the report and the patient problem is usually fairly clear. While traumas may be life-threatening situations, the handovers tend to occur in a more controlled setting than medical or multiple-patient handovers, which will likely look worse than what was found in this study. One previous study[20] examined the retention by ED staff of information transmitted in the ambulance handover and found that only 56.6% of information was accurately retained. This number serves to highlight the point that the controlled handover of the trauma patient may represent the best-case scenario, and the general handover of patients, which is often not even face-to-face, may present the potential for even greater data loss. This difference may serve as a starting point for discussion of improved data transmission. The potential exists for future studies to use this baseline to establish whether the loss of data is greater in multiple casualty or disaster scenarios, to eventually devise better ways of protecting the data transfer.

## Limitations and Future Research

There are several limitations to this study. One of the most notable was the unexpected 30% rate of videotape capture for full trauma evaluations, resulting in a smaller sample size than anticipated. This was due to a combination of factors, including failure to activate the videotaping system and delayed activation of the videotaping system (after the EMS handover) had been completed. However, given that the demographics of the study handovers are consistent with the general "full trauma" population seen at our institution, we believe this to be a representative sample (Table 3).

The EMS physicians extracting data from the charts did not have a process by which to resolve discrepancies. While the kappa score was found to be excellent, there may have been some minor variation in chart review and data extraction methods, such as difficulties in defining whether to give credit for partial information (e.g., whether to count a statement of "over 70 mph" or "high speed" instead of the actual crash speed), despite attempts at being very clear in these definitions ahead of time.

It is also possible that the trauma team either obtained information from a source other than the handover or knew information they did not record in the chart, resulting in an inaccurate estimate of the degree of information loss. It is impossible in this study to differentiate problems with documentation from problems with information loss during transmission; a different study design with real-time interview of the trauma team would be necessary to evaluate this. Both, however, are important problems in the ongoing care of patients requiring the involvement of multiple health care professionals because the chart remains the only permanent record of the information, and care, provided. The on-call trauma team is not necessarily made up of the same people as the team caring for the patient on the ward. It is unlikely that the unavailable charts represented trauma patients who were any different from those for which there were complete charts, though it is possible that the unavailable charts represented busier time periods where there is greater potential for information loss. The team, however, still listens to one handover at a time.

## CONCLUSION

Even in the controlled setting of a single-patient handover with direct verbal contact between health care providers, only 72.9% of the key prehospital data points that might affect patient outcome and were provided by EMS personnel were documented by the receiving trauma team. Elements such as prehospital hypotension, GCS score, and other vital signs were often not recorded by the trauma team. Methods of "transmitting" and "receiving" data in trauma as well as all other patients need further scrutiny.

## References

1. Beach C, Croskerry P, Shapiro M. Profiles in patient safety: emergency care transitions. Acad Emerg Med. 2003;10:354–7.

2. Stiell A, Forster AJ, Stiell IG, van Walraven C. Prevalence of information gaps in the emergency department and the effect on patient outcomes. CMAJ. 2003;169(10): 1023–8.
3. Alvarado K, Lee R, Christoffersen E, et al. Transfer of accountability: transforming shift handover to enhance patient safety. Healthc Q. 2006 Oct;9 (Sp):75–9.
4. Davis DP, Serrano JA, Vilke GM, et al. The predictive value of field versus arrival Glasgow Coma Scale score and TRISS calculations in moderate-to-severe traumatic brain injury. J Trauma. 2006;60:985–90.
5. Tien HC, Cunha JR, Wu SN, et al. Do trauma patients with a Glasgow Coma Scale score of 3 and bilateral fixed and dilated pupils have any chance of survival? J Trauma. 2006;60: 274–8.
6. Shafi S, Gentilello L. Pre-hospital endotracheal intubation and positive pressure ventilation is associated with hypotension and decreased survival in hypovolemic trauma patients: an analysis of the National Trauma Data Bank. J Trauma. 2005;59:1140–5; discussion 1145–7.
7. Gabbe BJ, Cameron PA, Wolfe R, Simpson P, Smith KL, McNeil JJ. Prehospital prediction of intensive care unit stay and mortality in blunt trauma patients. J Trauma. 2005:59:458–65.
8. Davis DP, Vadeboncoeur TF, Ochs M, Poste JC, Vilke GM, Hoyt DB. The association between field Glasgow Coma Scale score and outcome in patients undergoing paramedic rapid sequence intubation. J Emerg Med. 2005;29:391–7.
9. Deakin CD, Sado DM, Coats TJ, Davies G. Prehospital end-tidal carbon dioxide concentration and outcome in major trauma. J Trauma. 2004;57:65–8.
10. Arbabi S, Jurkovich GJ, Wahl WL, et al. A comparison of prehospital and hospital data in trauma patients. J Trauma. 2004;56:1029–32.
11. Lerner EB, Billittier AJ, Dorn JM, Wu YW. Is total out-of-hospital time a significant predictor of trauma patient mortality? Acad Emerg Med. 2003;10:949–54.
12. Shapiro NI, Kociszewski C, Harrison T, Chang Y, Wedel SK, Thomas SH. Isolated prehospital hypotension after traumatic injuries: a predictor of mortality? J Emerg Med. 2003;25:175–9.
13. Luk SS, Jacobs L, Ciraulo DL, Cortes V, Sable A, Cowell VL. Outcome assessment of physiologic and clinical predictors of survival in patients after traumatic injury with a trauma score less than 5. J Trauma. 1999;46:122–8.
14. Servadei F, Nasi MT, Cremonini AM, Giuliani G, Cenni P, Nanni A. Importance of a reliable admission Glasgow Coma Scale score for determining the need for evacuation of posttraumatic subdural hematomas: a prospective study of 65 patients. J Trauma. 1998;44:868–73.
15. Henry MC, Hollander JE, Alicandro JM, Cassara G, O'Malley S, Thode HC Jr. Incremental benefit of individual American College of Surgeons trauma triage criteria. Acad Emerg Med. 1996;3:992–1000.
16. Milzman DP, Boulanger BR, Rodriguez A, Soderstrom CA, Mitchell KA, Magnant CM. Pre-existing disease in trauma patients: a predictor of fate independent of age and injury severity score. J Trauma. 1992;32:236–43; discussion 243–4.
17. Thakore S, Morrison W. A survey of the perceived quality of patient handover by ambulance staff in the resuscitation room. Emerg Med J. 2001;18:293–6.
18. Jenkin A, Abelson-Mitchell N, Cooper S. Patient handover: time for a change? Accid Emerg Nurs. 2007;15:141–7.
19. Bruce K, Suserud B. The handover process and triage of ambulance-borne patients: the experiences of emergency nurses. Nurs Crit Care. 2005;10(4):201–9.
20. Talbot R, Bleetman A. Retention of information by emergency department staff at ambulance handover: do standardized approaches work? Emerg Med J. 2007;24:539–42.