

Review

Accuracy of call-taker assessment of patient level of consciousness: a systematic review

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Abstract

Introduction

When triaging an emergency phone call for ambulance assistance, one of the key areas of questions asked in internationally used triage decision support systems is around the patient's level of consciousness. A patient with a reduced level of consciousness can be indicative of a requirement for a high level of urgency of ambulance response. However, the value of this as a triage criterion is dependent on how accurately it can be determined by the call-taker. We sought to identify and summarise the results from published studies which determine the accuracy of call-taker assessment of conscious state during an emergency phone call.

Methods

We searched MEDLINE, EMBASE, CINAHL and Scopus databases for studies relating to concepts of emergency medical services, conscious state, triage and/or accuracy. Studies were screened and included if they dealt with emergency calls in the community, reported call-taker determination and on-scene determination of conscious state, and included sufficient data for at least one measure of diagnostic accuracy to be calculated.

Results

Out of 5753 articles initially identified, only two were found that matched the inclusion criteria. Both reported accuracy of a binary determination of consciousness versus unconsciousness, and found that it is common for the reported consciousness to differ from actual findings at scene. There were no studies identified that measured accuracy of determination of altered conscious states among conscious patients.

Conclusion

There is a notable gap in the literature regarding accuracy of determination of the patient's conscious state in an emergency call, which needs to be addressed.

Keywords:

emergency dispatch; pre-hospital care; conscious state; triage; accuracy

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Background

In an emergency ambulance call, one of the key roles of the call-taker is to determine the nature of the emergency in order to prioritise the response, so that the right level of care is sent to the patient in the right timeframe. Ambulance services worldwide have reported inaccuracies in triage (1-7), in terms of both under-triage (ambulance dispatched at a lower priority than required) and over-triage (ambulance dispatched at a higher priority than required). Whereas under-triage may directly compromise the safety of the patients involved, reducing over-triage is also an important consideration so that ambulances remain available for those patients who have the greatest need for a high priority response (8,9).

Level of consciousness is an important criterion for triaging patients that is used in emergency medical dispatch systems around the world (10,11). Complete loss of consciousness may be indicative of a sudden severe medical condition or traumatic injury, and even in the absence of a highly acute cause, patients may be at risk of airway occlusion. In conscious patients, even reduced alertness (or reduced conscious state) can indicate a need for urgent attention, eg. due to hypoglycaemia, head trauma, stroke or poisoning. It is therefore reasonable that information about a patient's level of consciousness provides useful information about their need for urgent care. However, the value of this information in emergency ambulance calls relies on how accurately a patient's level of consciousness can be determined during calls, with inaccuracies having potentially important implications for ambulance services in terms of both under- and over-triage.

The purpose of this systematic review is to examine published studies to determine call-takers' accuracy to determine patients' level of consciousness in emergency calls to ambulance services.

Methods

This systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement (12). Details of the protocol were registered on PROSPERO (13) (CRD42019116403).

Study question

The review question was: In the setting of an emergency call to an emergency medical service (EMS), does the call-taker's determination of a patient's level of consciousness accurately predict the patient's level of consciousness as found by EMS responders? This question was based on the PICO model (14,15): P (Population) = Patients in the community for whom an ambulance is called; I (Intervention/index test) = Call-taker determination of patient conscious state; C (Comparison/reference test): Findings of conscious state by responder attending the patient; O (Outcome) = Measures of diagnostic accuracy of call-taker determination.

Inclusion criteria

Studies were included in the review if they: dealt with calls for help to an emergency medical service in the community; directly reported the call-taker's determination of the patient's level of consciousness; and directly compared call-taker determination of consciousness to the patient's level of consciousness as determined on arrival of EMS responders. For a study to be included, it had to report at least one measure of diagnostic accuracy, or provide data that enabled at least one measure of diagnostic accuracy to be calculated.

Callers were defined as 'in the community' if the call was a call for help for a patient not already in the health system (as opposed to, for example, a call to transfer an already-admitted patient from one facility to another). EMS responders were defined as any personnel responding as part of the emergency medical system; whether health professionals such as doctors, nurses or paramedics – or other rescuers such as volunteers, police officers or firefighters – so long as the rescuer had sufficient training to assess and record a patient's level of consciousness. No restrictions were applied in relation to dates or language.

Data sources

We searched MEDLINE, EMBASE, CINAHL and Scopus databases for studies. Reference lists for included articles were also searched to locate any additional resources. The search strategy looked for articles matching concepts of (a) emergency medical services AND (b) conscious state AND (c) triage OR accuracy. This strategy (particularly the inclusive approach of searching for 'triage OR accuracy') was designed to capture as many potentially relevant articles as possible. Preliminary searches of the literature found that disparate keywords were used for articles around this subject, so a wide range of search terms for these concepts were used to capture the breadth. The search strategy was developed in conjunction with a Curtin University librarian. The full MEDLINE search strategy is shown in Table 1.

Study selection

Author 1 (JB) performed the database searches. Duplicates were removed, and titles and abstracts were independently reviewed by Author 1 (JB) and Author 4 (SB) to locate potential studies. JB and SB then independently assessed the full text of potential studies to determine if eligibility criteria were met. Consensus was reached by discussion, for any disagreements or uncertainties.

Data collection process

Data was extracted from included studies onto a Microsoft Word table detailing: the study setting (location and year); study design; outcome measure (and definition); call-taker qualification; EMS responder qualification; number of cases; and data sources for call-taker and EMS responder assessment.

Table 1. MEDLINE search strategy

1. 'emergency medical services'
2. EMS
3. EMT
4. 'emergency medical technician'
5. paramedic
6. ambulance
7. prehospital
8. pre-hospital
9. 'Emergency Medical Services/'
10. exp Emergency Medical Services/
11. exp Ambulances/
12. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11
13. awareness/ or comprehension/
14. GCS
15. 'glasgow coma'
16. 'avpu'
17. 'altered conscious state'
18. 'conscious state'
19. alertness
20. alert or conscio* or cognit* or awake
21. 'Unconscious (Psychology)'/
22. 'CONSCIOUSNESS DISORDERS'/ or exp CONSCIOUSNESS/
23. 'Consciousness Disorders'/ or 'Brain Injuries'/
24. 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23
26. 'call taker'
27. 'calltaker'
28. telephone. or TELEPHONE/
29. triage or TRIAGE/
30. exp 'EMERGENCY MEDICAL DISPATCH'/ or dispatch
31. exp 'Emergency Medical Service Communication Systems'/
32. Communication/ or Triage/ or Hotlines/ or Telephone/
33. 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32
34. reliability
35. accuracy
36. exp 'reproducibility of results'/
37. accurate
38. agreement
39. concordance
40. inter-rater
41. 34 or 35 or 36 or 37 or 38 or 39 or 40
42. 12 and 24 and 33
43. 12 and 24 and 41
44. 42 or 43

Summary measures

Measures of diagnostic accuracy (sensitivity, specificity, positive predictive value and/or negative predictive value) were reported for each study (and calculated from raw data if required). Where 95% confidence intervals were not provided, they were calculated using Clopper-Pearson exact confidence intervals (16).

Quality and risk of bias

The QUADAS-2 tool for quality assessment of diagnostic studies (17) was used for assessment of quality and risk of bias. QUADAS-2 rates risk of bias (as 'low', 'high' or 'unclear'), across the domains of 'patient selection', 'index test', 'reference standard' and 'flow and timing'. Studies were individually assessed using the QUADAS-2 worksheet (18) by two reviewers (Author 1 and Author 4), and consensus reached by discussion.

Results

A total of 5753 articles were returned through database searches (after removal of duplicates). Titles and abstracts were screened, identifying six potentially relevant articles (19-24). These articles were then reviewed in full text against the inclusion criteria, yielding two articles which were ultimately included in the review (19,24) (Figure 1).

Characteristics of excluded studies

Of the six studies reviewed in full text, the four excluded studies are shown in Table 2. Reasons for exclusion were that the patient's conscious state at the scene was not reported (n=2) (20,23), or that the data did not enable calculation of any measure of diagnostic accuracy (n=2) (21,22).

Table 2. Excluded studies

Study	Country	Reason(s) for exclusion
Clawson et al (2010) (20)	US	Demonstrated a potential association between 'not alert' as determined in a phone call and patient acuity; however did not directly compare field findings of conscious state
Gibson et al (2013) (21)	UK	Discussed communication difficulties around conscious state determination in emergency calls for stroke, did not include sufficient data to determine call-taker assessment of conscious state and thus calculate any measure of diagnostic accuracy
Jones et al (2011) (22)	UK	Did not itself include sufficient data to calculate any measure of diagnostic accuracy (conference abstract reporting on same study as Gibson et al) (21)
Ohshige et al (2009) (23)	Japan	Formulated an algorithm to predict patient acuity based on several factors in a phone call, including conscious state, however did not directly compare field findings of conscious state

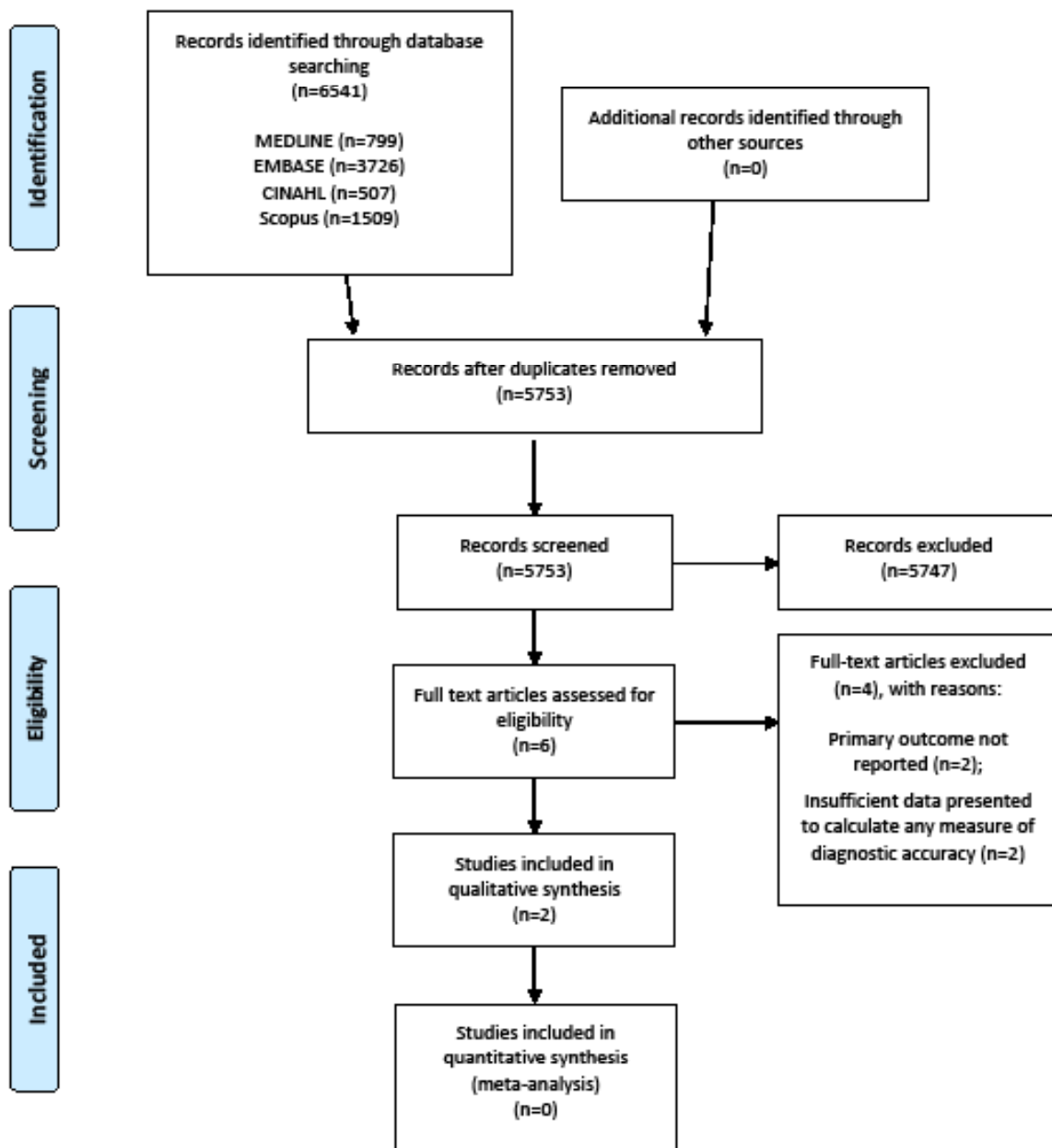


Figure 1. PRISMA flow diagram

Study characteristics

The two included studies (19,24) were retrospective observational studies. Their characteristics are summarised in Table 3. Both studies measured conscious state as determined by the call-taker during the emergency call, along with conscious state as determined by the EMS responder who attended the patient. However, there were notable differences in the objectives of the two studies. Radonic et al (24) sought to describe the characteristics of patients who were reported to be unconscious at the time of the emergency call (ie. allowing calculation of positive predictive value, but not other measures of diagnostic accuracy). In contrast, Bach & Christensen (19) examined all quadrants of the comparison between call-taker and on-scene assessment of conscious state (ie. conscious vs. unconscious as assessed by call-taker, compared to conscious vs. unconscious as determined on-scene), allowing calculation of sensitivity, specificity, positive predictive value and negative predictive value.

Both studies (19,24) measured consciousness as a binary variable (conscious vs. unconscious) and did not examine the spectrum of altered conscious states or reduced levels of consciousness. Bach & Christensen (19) defined 'unconscious' as a Glasgow Coma Scale (GCS) (25) score of less than 9, while the distinction between conscious and unconscious was not defined by Radonic et al (24).

Synthesis of results

Along with the disparate nature of studies already identified, differences in the designs of emergency medical systems also make the studies difficult to compare. Radonic et al (24) studied a hospital-based system where calls were handled by emergency doctors. Bach & Christensen (19) based their study on a system where calls are answered by a police call centre. Due to the disparate nature of studies, and different skills levels of the call-takers, we considered there is too much clinical heterogeneity for meta-analysis.

Results of individual studies

Results for each study, with calculated measures of diagnostic accuracy, are shown in Tables 4a and 4b.

Radonic et al (24) selected 1352 patients who were identified as unconscious in the emergency call. Medical records were missing for 435 patients; thus 917 patient records were reviewed. Of these patients, 602 were found to be unconscious at scene (including 180 deceased patients) and 315 conscious, giving a positive predictive value of 65.6% for call-taker determination of unconsciousness.

Bach & Christensen (19) reviewed 1655 calls for accuracy of call-taker determination of conscious state. Of the 1024 patients classified by call-takers as conscious, 972 were found on-scene to be conscious and 52 unconscious. Of 631 classified by call-takers to be unconscious, 388 were conscious on-scene and 243 unconscious. This gives a sensitivity of 82.4%, specificity of 71.5%, positive predictive value of 38.5% and negative predictive value of 94.9%.

Table 4a. Bach & Christensen (19)

	On-scene: unconscious	On-scene: conscious	Total
Call-taker: Unconscious	243	388	631
Call-taker: Conscious	52	972	1024
Total	295	1360	1655

Diagnostic accuracy of identifying unconscious patients: sensitivity = 82.4% (95% CI: 77.5-86.6%); specificity = 71.5% (95% CI: 69.0-73.9%); positive predictive values (PPV) = 38.5% (95% CI: 36.2-40.9%); negative predictive values (NPV) = 94.9% (95% CI: 93.6-96.0%)

Table 4b. Radonic et al (24)

	On-scene: unconscious	On-scene: conscious	Total
Call-taker: unconscious	602	315	917
Call-taker: conscious	Not reported	Not reported	Not reported
Total	Not reported	Not reported	Not reported

PPV of identifying unconscious patients = 65.6% (95% CI: 62.5-68.7%); sensitivity, specificity and NPV not ascertainable

Table 3. Included studies

Study	Country	Study type	Triage decision support tool	Outcome measure	Call-taker type	On-scene assessor type	# of cases analysed	Data source for call-taker findings	Data source for on-scene findings
Bach & Christensen (2007) (19)	Denmark	Observational, retrospective	Criteria based dispatch (11)	Unconscious (GCS<9)	Police	Doctor	1655	Dispatch data	Patient care records
Radonic et al (1995) (24)	Croatia	Observational, retrospective	Not specified	Unconscious (measure not defined)	Doctor	Doctor	917	Medical records	Medical records

Quality and bias assessment

Results for the assessment of quality and risk of bias (using QUADAS-2) (17) are summarised in Table 5.

The index test (call-taker assessment of conscious state) in Bach & Christensen (19) was based on a triage decision support tool, which we interpreted as providing some degree of consistency in conscious state assessment between calls. The basis for call-taker assessment of conscious state was not specified in Radonic et al (24); therefore it is unclear whether a lack of a systematic approach to call-taker determination of conscious state may have contributed to bias in this study. In relation to the reference test (on-scene assessment of conscious state), Bach & Christensen (19) specified a threshold GCS of less than 9 as defining unconsciousness. We assigned a low risk of bias to this determination, due to its formal definition, and the fact that it was determined by medical experts (in this study, anaesthesiologists). No definition of consciousness was supplied in Radonic et al (24). However, given the binary nature of the on-scene classification (conscious vs. unconscious), and the fact that on-scene assessment of conscious state was made by clinicians, we assigned this study a low risk of bias in the reference standard.

In terms of study flow and timing, both studies had a large number of patients excluded due to missing variables or unlinked data, thereby introducing potential bias. In Bach & Christensen (4), of the study's starting cohort of 2961 emergency calls allocated a Mobile Emergency Care Unit (MECU), only 1655 cases (56%) remained in the final study population. In Radonic et al (24), data were missing for on-scene patient assessment for a large part of the study cohort: 435 of 1352 records (32%). Furthermore, the number of cases missing the index test for this study (ie. before the starting cohort of 1352 cases) is not stated.

For both studies (19,24), there were significant limitations in applicability to the review question. While Radonic et al (24) examined a broad selection of patients (apparently across all medical conditions), their study was restricted to patients assessed by call-takers as being unconscious. Bach & Christensen (19) also examined a broad selection of patients (across all medical conditions), and examined patients assessed by call-takers as both conscious and unconscious. However, their cohort was restricted to those patients assessed

by the call-taker as being higher acuity, identified as patients who were allocated MECU at dispatch (MECU physicians are only allocated to higher acuity patients in their system).

Discussion

Reduced conscious state is a key factor in determining patient acuity in systems used internationally for triaging emergency calls. Determining whether the patient is conscious or not is typically one of the first and most important triage questions asked in all emergency calls (along with whether the patient is breathing) (10,11). Furthermore, for patients initially identified as conscious, it is common among dispatch protocols for further questions to be asked to determine if the patient has an altered conscious state (10,11). Despite the importance of determining conscious state, this systematic review identified very little literature providing a quantitative assessment of the accuracy of call-taker assessment of conscious state.

Only one study (Bach & Christensen) (19) provided all measures of diagnostic accuracy of determining conscious state (sensitivity, specificity, PPV and NPV). Bach & Christensen (19) compared call-takers determination of whether the patient was conscious with medical professionals' determination of whether the patient was conscious on arrival at the scene, and found a sensitivity (of determining the patient as unconscious) of 82.4%, specificity of 71.5%, NPV of 94.9% and PPV of 38.5%. This is the only study to date to have reported on the sensitivity, specificity and NPV of determining conscious state during emergency calls, and is therefore significant in providing the only comprehensive evidence that it is common for call-taker assessment of conscious state to differ from what is found by clinicians on-scene. Rephrasing the statistics above in terms of inaccuracies (ie. discordant determinations of conscious state), 17.6% of patients who were unconscious on-scene were classified as conscious during the call (1-sensitivity); 28.5% of patients who were conscious on-scene were classified as unconscious during the call (1-specificity), and 61.5% of patients dispatched as unconscious were found to be conscious on-scene (1-PPV). The only statistic with high accuracy was the NPV, with only 5.1% of patients dispatched as conscious being found to be unconscious on-scene (1-NPV).

One feature of the Bach & Christensen (19) study was a tendency towards false positives (patient determined as

Table 5. QUADAS-2 results

Study	Risk of bias				Applicability concerns		
	Patient selection	Index test	Reference standard	Flow and timing	Patient selection	Index test	Reference standard
Bach & Christensen (2007) (19)	☑	☑	☑	☒	☒	☑	☑
Radonic et al (1995) (24)	☑	?	☑	☒	☒	☑	☑

☑ = Low risk ☒ = High risk ? = Unclear risk

unconscious in the call, but conscious on-scene), over false negatives (determined as conscious in the call, but unconscious on-scene). This is evident in the sensitivity (of identifying the patient as unconscious) being higher (at 82.4%) than the specificity (71.5%), as well as the NPV (94.9%) being higher than the PPV (38.5%). This tendency is consistent with the generally risk-averse approach of EMS dispatch (1-7). However, while this could be interpreted as evidence of a conservative approach to call-taker determination of unconscious patients, it is also possible that a tendency towards false positives could arise from transitions in patient conscious state in the period between the emergency call and arrival at the scene, ie. if the likelihood of unconscious patients becoming conscious, is higher than conscious patients becoming unconscious. One way to measure the impact of changes in patient conscious state between the emergency call and arrival on-scene, could be to statistically model how the measures of diagnostic accuracy vary as a function of response time. This was outside the scope of the Bach & Christensen study (19) but could be an informative aspect of future research.

The second study in this review (Radonic et al) (24) restricted their study cohort to calls that were initially classified by the call-taker as an unconscious patient, and then examined how the patient's conscious state was classified by clinicians on arrival to the scene. Therefore, the only measure of diagnostic accuracy that could be calculated from this study was PPV, which had a value of 65.6%. This is much higher than the PPV of 38.5% reported by Bach & Christensen (19). Without the full picture of all measures of diagnostic accuracy, there is no indication of whether the higher PPV in the Radonic et al (24) study came at the cost of decreased sensitivity to detect unconscious patients. Furthermore, differences in study design make meaningful comparisons of the PPV between these two studies difficult – in particular, the study cohort for Bach & Christensen (19) was restricted to higher acuity calls (receiving MECU), whereas the study cohort for Radonic et al (24) was not restricted by patient acuity. Regardless of the reasons for the higher PPV in the Radonic et al (24) study, this study is important in further highlighting that it is common for call-taker assessment of conscious state to differ from what is found by clinicians on-scene.

Two additional studies that were excluded from this review remain noteworthy. Gibson et al (21) reported on emergency calls for patients exhibiting stroke symptoms and the communication difficulties experienced. The study was not designed to quantitatively measure accuracy and instead was part of a qualitative project to investigate communication difficulties in the context of acute strokes. While this study did not provide data on the final call-taker determination of patient conscious state, or on-scene determination of conscious state, the qualitative component of this study provides useful insights into the challenges experienced when call-takers attempt to

glean information about a patient's conscious state, eg. callers had difficulty determining a conscious level, there was frequent miscommunication and a need to clarify conscious level, and callers conflated conscious level with breathing difficulties.

A study by Clawson et al (20) was excluded because the data were insufficient for a patient's conscious state at the scene to be determined. While cardiac arrest was an outcome variable (for which many patients will be unconscious at the time of the call, or on arrival at the scene), the cohort did not exclude EMS-witnessed arrests - therefore an unknown proportion of patients may have been conscious on EMS arrival at the scene. The focus of Clawson et al (20) was to examine the predictive value, among falls patients, of being classified in the emergency call as unconscious or not alert (vs. alert). While not assessing accuracy of conscious assessment per se, the Clawson et al study (20) is important in demonstrating the utility of call-taker questioning of conscious state. They found that falls patients classified in the emergency call as not alert or unconscious were more than 15 times more likely to have a cardiac arrest than falls patients classified as alert in the call (20).

Conscious state can be considered as a scale, with a patient fully aware, alert and oriented at one end of the spectrum and completely unresponsive at the other. Between these, other descriptors of conscious state can be used such as lethargic, confused, responsive to voice or responsive to pain. Binary descriptors of 'conscious' or 'unconscious' refer to patients with a conscious state above or below a certain point on this scale. The Bach & Christensen and Radonic et al studies (19,24) both measured this binary state of conscious versus unconscious. Bach & Christensen (19) defined 'unconscious' as a patient with a GCS (25) score of 8 or less, which can be approximated to include patients classed as responsive to pain or unresponsive on the AVPU (Alert, Verbal response, Pain response, Unresponsive) scale used for rapid conscious state assessment (26,27).

Patients with an altered conscious state but considered conscious may still have a condition requiring urgent attention, such as hypoglycaemia, head trauma or stroke. This is recognised in hospital emergency department triage systems where conscious patients with an altered conscious state are given a high priority, for example the Australasian Triage Scale (28) or Canadian Triage Acuity Scale (29).

Phone triage systems as used by ambulance services also recognise the potential urgency of altered conscious states where a patient is conscious, and attempt to discern these conscious states. Both the Medical Priority Dispatch System (MPDS) and Criteria Based Dispatch ask callers toward the beginning of the call if the patient is conscious, and further questioning about conscious state will often follow. In MPDS, 28 out of 33 chief complaint protocols ask: "is s/he completely

alert (responding appropriately)" (10). Criteria Based Dispatch includes questions about whether the patient is able to respond, follow simple commands and answer questions in 12 out of 26 of its chief complaints where an altered conscious state may be of concern. These questions should discriminate patients who are conscious but not alert (ie. fall in the verbal response category in the AVPU scale).

The two studies (19,24) included in this review may provide some evidence for recognition of unconscious patients, however there were no studies found that demonstrated reliability of this further questioning of altered conscious states in conscious patients. As this is a key part of the phone triage for many emergency calls, it is recommended that research be carried out to determine the reliability of this questioning.

Limitations

This review was limited solely to studies where accuracy of conscious state assessment could be measured. The question of accuracy is an important measure, as improvements in accuracy of conscious state assessment would be expected to lead to improvement of dispatch prioritisation. However, this necessarily meant that studies with other outcome measures of patient acuity which did not include conscious state at scene were excluded from the study. For example, studies investigating accuracy of cardiac arrest recognition in emergency calls were excluded because they did not report on findings of conscious state per se, even though questioning about consciousness may have led to the recognition of cardiac arrest.

Conclusion

There is a scarcity of published research into the accuracy of conscious state determination in emergency calls, with only two studies (19,24) providing quantitative measures. These studies both show it is common for call-taker assessment of conscious state to differ from what is found on-scene. From the only study (19) to include all measures of diagnostic accuracy (sensitivity, specificity, PPV and NPV), there appears to be a tendency toward false positives (patient determined as unconscious in the call, but conscious on-scene), over false negatives (determined as conscious in the call, but unconscious on-scene). Meta-analysis was not undertaken due to significant levels of clinical heterogeneity between studies. No studies examined the accuracy of determining patient conscious state for patients that are intermediate on the spectrum between fully alert and unconscious. Further research in this area is suggested.

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Conflict of interest

Jason Belcher and Austin Whiteside are employed full time by St John Western Australia (SJWA) as Ambulance Paramedic and Operations Manager respectively. Judith Finn receives partial salary support from SJWA, and both Judith Finn and Stephen Ball have adjunct appointments with SJWA.

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