Australasian Journal of Paramedicine

Research

'Is the patient completely alert?' – accuracy of emergency medical dispatcher determination of patient conscious state

Jason Belcher BSc is a MPhil candidate[1] and paramedic[2]; Judith Finn PhD, MEdSt, GradDipPH, BSc is Director[1] and Adjunct Research Professor[2]; Austin Whiteside PGCert(EMS), AdvDipHSc(PrehospCare) is Operations Manager and paramedic[2]; Stephen Ball BSc, PhD is Research Fellow[1] and Adjunct Senior Research Fellow[2]

Affiliations:
[1]Prehospital, Resuscitation and Emergency Care Research Unit, Curtin University, Perth, Western Australia
[2]St John Ambulance, Western Australia

https://doi.org/10.33151/ajp.18.858

Abstract

Introduction
During emergency ambulance calls, one of the key issues assessed is the patient's level of consciousness. An altered conscious state can be indicative of a need for a high priority response; however, the reliability of the resulting triage depends on how accurately alertness can be ascertained over the phone. This study investigated the accuracy of emergency medical dispatcher (EMD) determination of conscious state in emergency ambulance calls in Perth, Western Australia.

Methods
The study compared EMD determination of patient alertness based on the Medical Priority Dispatch System (MPDS), with conscious state as recorded by paramedics on arrival, for all emergency ambulance calls in a 1-year period in metropolitan Perth. Diagnostic accuracy was reported across the whole system and stratified by MPDS chief complaint.

Results
There were 109,678 calls included for analysis. In terms of identifying patients as not alert, the overall positive predictive value was 6.62% and negative predictive value was 99.93%, with 10 times as many patients dispatched as not alert than found to be not alert at scene. Sensitivity was only 69.94%. There was significant variation in accuracy between chief complaints.

Conclusion
The study found high levels of inaccuracy between dispatch identification of not-alert patients, and what paramedics found on scene. While not-alert dispatch was 10 times more common than patients being determined not-alert on scene, only 70% of not-alert patients on scene were classified as such during dispatch. Further research is suggested into the factors that affect the accuracy of EMD determination of patient conscious state.

Keywords:
emergency medical services; pre-hospital care; emergency dispatch; triage; conscious state; accuracy

Corresponding Author: Jason Belcher, jason.belcher@postgrad.curtin.edu.au

Introduction

In an emergency ambulance call, a key role of the emergency medical dispatcher (EMD) is to determine the nature and urgency of the medical or traumatic problem. Inaccuracies in this process can lead to under-triage, whereby the patient receives a lower priority response than necessary, with increased risk to the individual patient; as well as over-triage, whereby the patient receives a higher priority response than necessary, with a system-wide risk that resources become unavailable for patients who truly need a high priority response (1-4). Studies have shown widespread inaccuracies in initial telephone triage of patient acuity (5-11).

A key area of questioning in emergency ambulance calls is around patient conscious state – in terms of whether patients are conscious or unconscious, and altered conscious states among conscious patients. Among conscious patients, a sudden altered conscious state can be symptomatic of a high acuity condition such as stroke (12), head trauma (13), hypoglycaemia (14) or poisoning (15). Altered conscious states are recognised as a triage criterion in, for example, the Australasian Triage Scale (16) and international advanced trauma life support protocols (13). In the Medical Priority Dispatch System (MPDS) widely used in ambulance services around Australia and internationally for triage of ambulance calls, determination of patient alertness is used as a basis of dispatch prioritisation for 27 of the 32 chief complaints (17). However, the value of assessing patient conscious state during emergency calls depends on how accurately it can be determined. A recent systematic review (18) found only two studies (19,20) on the accuracy of call-taker determination of consciousness, and no studies on the accuracy of determining reduced conscious states among conscious patients.

To address this knowledge gap, this study sought to investigate the accuracy of EMD determination of reduced conscious state among conscious patients. This study took a system-wide approach to analysing the association between EMD determination of patient alertness and patient alertness recorded by paramedics on arrival at the scene. The primary aim was to estimate the overall accuracy of EMD determination of patient alertness, among patients initially identified as conscious. In addition, this study compared the accuracy of alertness determination between different patient medical conditions (MPDS chief complaints), with a view to target chief complaints for further research.

Methods

Setting

This was a population-based retrospective observational study of the association between EMD determination of patient alertness (using the MPDS) versus findings by paramedics at the scene, stratified by chief complaint. The setting was metropolitan Perth in Western Australia, population 2.06 million in 2018 (21), where St John Western Australia (SJWA) is the sole provider of emergency ambulance services and is staffed entirely by career paramedic crews (22). All emergency (000) ambulance calls in Western Australia are answered by SJWA's State Operations Centre and triaged using the MPDS, before being dispatched to an ambulance crew. SJWA employ layperson EMDs who are trained in the use of the MPDS and are assessed against a MPDS quality assurance program to ensure standards are maintained. There is a significant range of experience among the EMDs represented in this study, from those at the beginning of their career through to those with decades of service (with MPDS being used at SJWA since 2011).

The study ran for the 12 months from 27 November 2017 to 26 November 2018, during which MPDS v13 (17) was in use.

Table 1. The chief complaints used by the Medical Priority Dispatch System v13 (17)

01 Abdominal pain/problems
02 Allergies (reactions)/envenomations (stings, bites)
03 Animal bites/attacks
04 Assault/sexual assault
05 Back pain (non-traumatic/non-recent trauma)
06 Breathing problems
07 Burns (scalds)/explosion (blast)
08 Carbon monoxide/inhalation/HAZMAT/CBRN
09 Cardiac or respiratory arrest/death
10 Chest pain (non-traumatic)
11 Choking
12 Convulsions/fitting
13 Diabetic problems
14 Drowning (near)/diving/SCUBA accident
15 Electrocution/lightning
16 Eye problems/injuries
17 Falls
18 Headache
19 Heart problems/AICD
20 Heat/cold exposure
21 Haemorrhage/lacerations
22 Inaccessible incident/other entrapments (non-vehicle)
23 Overdose/poisoning (ingestion)
24 Pregnancy/childbirth/miscarriage
25 Psychiatric/abnormal behaviour/suicide attempt
26 Sick person (specific diagnosis)
27 Stab/gunshot/penetrating trauma
28 Stroke (cerebrovascular accident)
29 Traffic/transportation incidents
30 Traumatic injuries (specific)
31 Unconscious/fainting (near)
32 Unknown problem

Determination of alertness

For dispatch determination of alertness, the MPDS determinant code for each incident was used, as assigned by the EMD. Using the MPDS, an EMD allocates an emergency call to one of 32 chief complaints (Table 1) based on a caller's initial description of the problem. The EMD then uses a series of scripted questions related to that complaint to assign the relevant determinant code. There is a total of 525 determinant codes across the 32 MPDS chief complaints v13 (17).

Of the 32 MPDS chief complaints, 27 include a question about the patient's alertness: 'is s/he completely alert?' (17) (Table 2a), with a corresponding 'not alert' determinant code selected if the answer is negative (unless a higher severity determinant is relevant). A restriction of ProQA-Paramount (Priority Dispatch Corporation, Salt Lake City, Utah USA), the software used by SJWA to implement the MPDS, is that answers to individual questions cannot be automatically exported across multiple records. Alertness can be deduced, however, for the vast majority of MPDS determinant codes. This is because, in 27 chief complaints, the MPDS has a determinant code that is specific to 'not alert' patients. If a lower ranked code was selected, this indicates that the patient was recorded by the EMD as 'alert'. However, for determinants ranked higher than 'not alert', the answer to the alertness question remains ambiguous, and these cases were excluded from analysis (Table 2b).

Table 2a. Excluded chief complaint protocols that do not contain a 'not alert' determinant

09 Cardiac or respiratory arrest/death
12 Convulsions/fitting
22 Inaccessible incident/other entrapments (non-vehicle)
24 Pregnancy/childbirth/miscarriage
32 Unknown problem

Table 2b. Excluded determinant codes due to ambiguity in alertness. Within each chief complaint, these codes are positioned above (ie. considered to have higher acuity than) the 'not alert' determinant code

02E01 Allergies (reactions)/envenomations (stings, bites) > ineffective breathing
06E01 Breathing problems > ineffective breathing
07E01 Burns > person on fire
11E01 Choking > complete obstruction/ineffective breathing
11D01 Choking > abnormal breathing (partial obstruction)
14E02 Drowning (near)/diving/SCUBA accident > underwater (domestic rescue)
14D02 Drowning (near)/diving/SCUBA accident > underwater (specialised rescue)
14D03 Drowning (near)/diving/SCUBA accident > stranded (specialised rescue)
14D04 Drowning (near)/diving/SCUBA accident > just resuscitated and/or defibrillated (external)
15E01 Electrocution/lightning > not breathing/Ineffective breathing
15D03 Electrocution/lightning > not disconnected from power
15D04 Electrocution/lightning > power not off or hazard present
15D05 Electrocution/lightning > extreme fall (=>10 m/30 ft)
15D06 Electrocution/lightning > long fall
17D01 Falls > extreme fall (=>10 m/30 ft)
23D02 Overdose/poisoning (ingestion) > changing colour
29D01 Traffic/transportation incidents > major incident
29D02 Traffic/transportation incidents > high mechanism
29D03 Traffic/transportation incidents > high velocity impact
29D04 Traffic/transportation incidents > HAZMAT
29D05 Traffic/transportation incidents > trapped victim
31E01 Unconscious/fainting (near) > ineffective breathing

For on-scene determination of alertness, the AVPU assessment as recorded by paramedics on arrival at the scene was used. The four-level AVPU scale (Alert, Voice Response, Pain Response, Unresponsive) (15,23,24) is internationally recognised as a basis for rapid initial conscious state assessments in emergency patients. The levels of the AVPU scale are:

- Alert – patient is awake, can respond to normal voice, can make purposeful movements in response to command or stimulus, can converse
- Responds to voice – patient makes some kind of response (verbal, movement, eye opening) in response to a verbal stimulus (but is not alert)
- Responds to pain – patient makes some kind of response (verbal, movement, eye opening) to a painful stimulus (but not to any level above)
- Unresponsive – patient does not make any response to any stimulus.

SJWA paramedics complete an electronic patient care record for every patient they attend, which is linked to dispatch data by a unique case number.

Patients included

Cases were included for analysis if they were an emergency ambulance call for help in the community (ie. excluding interfacility transfers). Calls were excluded where: the call was dispatched as an unconscious patient, or cardiac or respiratory arrest; the MPDS chief complaint had no 'not alert' determinant (Table 2a); there was no patient contact (eg. call cancelled before patient contact, no patient found); there were multiple patients; conscious state was not recorded by paramedics; and the alertness on the MPDS code was ambiguous (Table 2b).

Analysis

The association between EMD determination and paramedic determination of conscious state (Figure 1) was measured using the following measures of diagnostic accuracy:

- sensitivity (proportion of paramedic-determined not-alert patients also determined as not-alert by EMD)
- specificity (proportion of paramedic-determined alert patients also determined as alert by EMD)
- positive predictive value (PPV) (proportion of EMD-determined not-alert patients also determined as not-alert by paramedics)
- negative predictive value (NPV) (proportion of EMD-determined alert patients also determined as alert by paramedics).

A true positive (for being not alert) was defined as where both the EMD and paramedics determined the patient to be not alert; a true negative where both determined the patient to be alert; a false positive if the EMD determined the patient to be not alert but paramedics determined them to be alert; and a false negative if the EMD determined the patient to be alert but paramedics determined them to be not alert.

These measures were calculated for the whole dataset, as well as stratified by chief complaints; 95% confidence intervals were calculated for these measures of diagnostic accuracy using Clopper-Pearson exact confidence intervals (25). Chief complaints were identified with the highest level of under-recognition of being not alert (false negatives – see Figure 1) along with the highest level of over-identification of being not alert (false positives). This study focussed on positive and negative predictive values in relation to over-triage and under-triage respectively, on the basis that these measurements show how reliably EMD triage questions predict on-scene paramedic findings. To compare chief complaints by positive and negative predictive value, the χ^2 test for heterogeneity was used, with a significance level of $p = 0.05$. Derived from this calculation, the row sum was used for each chief complaint as an indicator of the magnitude of that chief complaint's divergence from the mean – whereby a higher χ^2 row sum indicates greater deviation from the average value (PPV or NPV).

The data were imported into MySQL Community Edition version 8.0 (Oracle Corporation, Redwood Shores, California USA) to prepare summary data (Tables 3 and 4) and further analysed to produce measures of diagnostic accuracy and χ^2 tests (Tables 3 and 5) using Microsoft Excel for Macintosh version 16 (Microsoft Corporation, Redmond, Washington USA).

To meet the requirements of χ^2 analysis, any row with an expected value less than 1 was removed (26). It had been intended to remove rows with expected values less than 5 until less than 20% of cells had expected values below 5 (26), however there were no such rows after removing rows with expected values less than 1.

Sensitivity analysis

In addition to our primary analysis where paramedic-determined alertness was based on the AVPU scale, we undertook a sensitivity analysis with a more restrictive definition of paramedic-determined alert patients. As an extension of the AVPU scale, SJWA paramedics further classify patients who are alert on the AVPU scale into three sub-categories: alert, drowsy or confused. SJWA has placed the descriptors of 'drowsy' and 'confused' hierarchically above 'voice response'. Patients meeting these descriptions as used by SJWA are still able to converse during patient assessment and therefore would meet the definition of 'alert' on the AVPU scale. In our sensitivity analysis, we re-analysed the overall association between dispatch-determined alertness and paramedic-determined alertness, where on-scene alert patients were defined specifically as the subset of AVPU alert patients who were neither confused nor drowsy.

This sensitivity analysis recognises that patient conscious state lies along a spectrum, along with the fact that 'not alert' is not, to our knowledge, formally defined within the MPDS; and allows for the possibility that a dispatch interpretation of alertness is more closely aligned with categorising drowsy or confused patients as not alert.

Ethics

Approval for the study was granted by the Curtin University Human Research Ethics Committee as a sub-study of the Western Australian Pre-hospital Care Record Linkage Project (HR128/2013-46); and by the SJWA Research Governance Committee.

		Paramedic assessment on arrival		
		Not alert	Alert	
EMD assessment	Not alert	True positive (TP)	False positive (FP)	PPV = TP/(TP + FP) % of patients dispatched not-alert who were not-alert on scene
	Alert	False negative (FN)	True negative (TN)	NPV = FN/(FN + TN) % of patients dispatched as alert who were alert on scene
		Sensitivity = TP/(TP + FN) % of not alert patients on scene who were dispatched not alert	Specificity = TN/(FP + TN) % of alert patients on scene who were dispatched as alert	

Figure 1. Measures of diagnostic accuracy used in this study

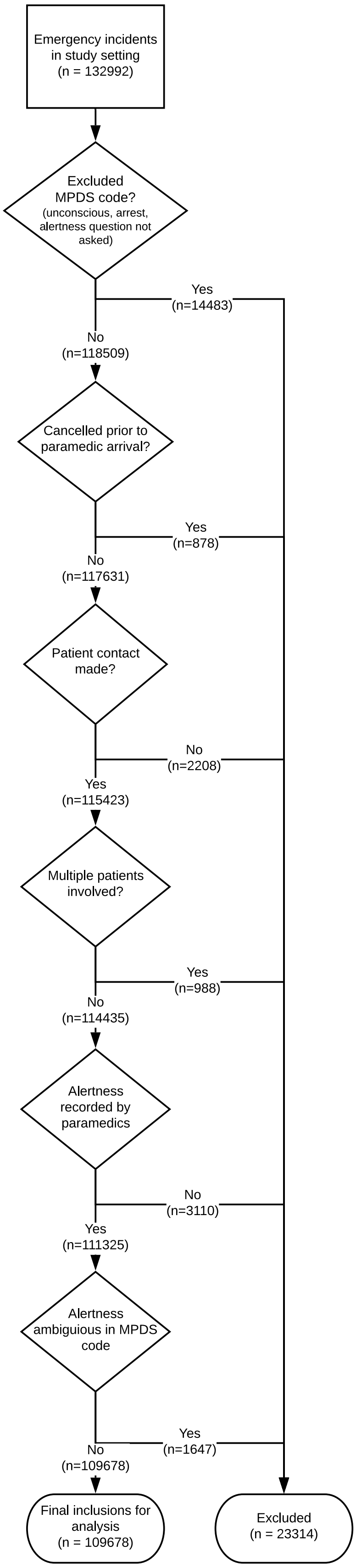

Figure 2. Flow diagram for inclusion and exclusion criteria

Results

Of the 132,992 incidents involving an emergency ambulance call to SJWA, 109,678 met the study inclusion criteria (82.47%) (Figure 2). In total, 19,359 incidents (17.65%) were dispatched as 'not alert', while there was a total of 1833 incidents (1.67%) where paramedics recorded the patient as not alert on arrival. Overall sensitivity was 69.94% (95% CI: 67.78-72.03%), and specificity was 83.24% (95% CI: 83.01-83.46%) (Table 3).

Of the 19,359 incidents where the patient was dispatched as 'not alert', 1282 were recorded by paramedics as being not alert. Therefore, the overall PPV was 6.62% (95% CI: 6.28-6.98%) (Table 3). Of the 18,077 false positive cases, the most common MPDS chief complaints were unconscious/fainting (near) (18.68%), breathing problems (12.07%), falls (11.88%) and sick person (11.70%) (Table 4).

Of the 90,319 incidents where the patient was dispatched as 'alert', 89,768 were found to be alert on paramedic arrival. Therefore, the overall NPV was 99.39% (95% CI: 99.34-99.44%) (Table 3). Of the 551 false negative cases (dispatched as alert, but recorded by paramedics as not alert), the most common MPDS chief complaints were sick person (28.86%), breathing problems (21.60%), falls (10.16%) and overdose/poisoning (8.17%) (Table 4).

There was significant variation in PPV between MPDS chief complaints (χ^2=216.64, df=18, p<0.0001), and significant variation in NPV between chief complaints (χ^2=355.09, df=18, p<0.0001) (Table 5).

Of the 18,077 false positive cases (dispatched as not alert but found to be alert by paramedics), 2831 (15.6%) were recorded by paramedics as 'drowsy' and 2493 (13.8%) as 'confused' (ie. SJWA subsets of the AVPU alert category) (Table 3). Conversely, of the 5282 patients recorded by paramedics as drowsy, 2831 (53.6%) were dispatched as not alert; and of the 7332 patients recorded by paramedics as confused, 2943 (40.1%) were dispatched as not alert (Table 3).

The sensitivity analysis showed that changing the definition of not alert to include patients categorised by paramedics as drowsy or confused resulted in an increase of PPV to 33.12% (95% CI: 33.46-34.80%) and specificity to 86.67% (95% CI: 86.45-86.89%) but a decrease in NPV to 91.82% (95% CI: 91.64-91.99%) and sensitivity to 47.19% (95% CI: 46.37-48.03%).

Discussion

This study found high levels of inaccuracy between dispatch determination of alertness and what paramedics found on scene. There were more than 10 times as many cases dispatched as not alert than the number recorded by paramedics as not alert on arrival at the scene. This system appears highly risk averse in the detection of not alert patients, with a low PPV (6.62%) and high NPV (99.39%).

Typically, the aim of a risk averse approach is to achieve a high level of sensitivity (ie. to ensure positive cases are identified) (3). However, despite a high ratio of not alert dispatch to not alert patients on scene, the study found a modest sensitivity in the detection of not alert patients (69.94%). Therefore, of all patients found to be not alert on scene, three in every 10 were dispatched as alert (ie. false negatives). Rather than this being a truly over-triaged system per se (in terms of low PPV and high sensitivity to detect not alert patients), this would be better described as a risk averse system that is not achieving high sensitivity. This shows that both false negatives, and false positives are important in relation to determination of patients being not alert. Furthermore, when a system-wide sensitivity analysis on the definition of paramedic-determined alertness was applied (excluding drowsy and confused patients from the definition of alert patients), sensitivity was only lower, at 47%.

Conscious state exists on a spectrum, with various scales used to measure it, eg. the AVPU from 'alert to unresponsive' or Glasgow Coma Scale (27) from 15 to 3. Asking 'is s/he completely alert?' requires the caller to give a yes or no answer to a question that lies on a continuum. The caller (or EMD if a binary answer is not provided by the caller), must therefore judge where to make the cut-off between alert and not alert. Evidence for the subjective nature of this decision may lie in the high levels of variation observed among patients recorded by paramedics as drowsy or confused (subsets of alert on the AVPU scale), with 53.6% of drowsy patients, and 36.2% of confused patients having been dispatched as not alert.

The study found statistically significant variation between chief complaints in PPV – the proportion of not alert patients (on dispatch) being found to be not alert by paramedics. Some of the highest PPVs were in complaints where an altered conscious state is a likely symptom: diabetic problems (PPV 10.94%), overdose/poisoning (PPV 9.43%), stroke (PPV 9.84%) and unconscious/fainting (near) (PPV 8.01%). Conversely, some of the lowest PPVs were in complaints of pain: abdominal pain (PPV 1.78%), chest pain (PPV 2.46%), headache (PPV 1.44%) and back pain (PPV 0%). Although some of this may be explained by the statistical calculation of PPV where a higher incidence of a condition will automatically increase the PPV, the study also found much higher sensitivity (which is independent of incidence) in most of these complaints with high PPV, and below average sensitivity in those with low PPV. It stands to intuitive reason that where an altered conscious state is more likely to be the trigger for the emergency call, there will be a higher incidence of a patient being correctly identified as being not alert, whereas a patient complaining of pain would generally have some level of alertness to be able to communicate this. Targeted research into complaints with particularly low PPV is suggested as this may highlight areas for future improvement in triage questioning to reduce the number of false positives in identifying not alert patients.

There was also statistically significant variation between chief complaints in NPV – the proportion of alert patients (on dispatch) found to be alert by paramedics. The chief complaints of breathing problems, overdose/poisoning, sick person, and stroke were highlighted as having a lower than average NPV. That is, these chief complaints had a higher than average proportion of alert patients (on dispatch) found to be not alert by paramedics (ie. higher false omission rate, 1-NPV). This highlights chief complaints that may be suitable targets for research into reducing the number of false negatives.

For more accurate assessment of alertness, different or further questioning may be required. This could take the form of a secondary triage system after the initial triage interview (2) or asking different questions in the initial triage sequence. A recent study found that using the clarifier question (asked if the caller

		Paramedic assessment on arrival			
		Not alert	Alert	Total	
EMD triage assessment	Not alert	1282: 503 voice response; 584 pain response; 195 unresponsive	18,077: 12,753 alert; 2831 drowsy; 2493 confused	19,359	PPV = 6.62% (95% CI: 6.28-6.98%)
	Alert	551: 238 voice response; 207 pain response; 106 unresponsive	89,768: 82,928 alert; 2451 drowsy; 4389 confused	90,319	NPV = 99.39% (95% CI: 99.34-99.44%)
	Total	1833	107,845	109,678	
		Sensitivity = 69.94% (95% CI: 67.78-72.03%)	Specificity = 83.24% (95% CI: 83.01-83.46%)		

Table 3. Diagnostic accuracy of EMD-determination vs on-scene paramedic-determination of patient alterness

Table 4. EMD assessment vs paramedic findings on arrival for patient alertness, by MPDS chief complaint

MPDS chief complaint	Total cases	Not alert dispatch	% not alert dispatch	Not alert at scene	% not alert at scene	True positive	False positive	False negative	True negative
01 Abdo. pain/problems	5508	506	9.19%	15	0.27%	9	497	6	4996
02 Allergies/envenom.	1778	239	13.44%	17	0.96%	9	230	8	1531
03 Animal bites/attacks	95	6	6.32%	0	0.00%	0	6	0	89
04 Assault/sex assault	2134	370	17.34%	23	1.08%	12	358	11	1753
05 Back pain	2483	112	4.51%	1	0.04%	0	112	1	2370
06 Breathing problems	13,579	2370	17.45%	307	2.26%	188	2182	119	11,090
07 Burns/explosion	250	3	1.20%	2	0.80%	0	3	2	245
08 CO/Inh./HAZ/CBRN	52	16	30.77%	2	3.85%	2	14	0	36
10 Chest pain	16,162	1016	6.29%	50	0.31%	25	991	25	15,121
11 Choking	107	10	9.35%	2	1.87%	1	9	1	96
13 Diabetic problems	1278	850	66.51%	96	7.51%	93	757	3	425
14 Drowning/diving/SCUBA	31	15	48.39%	1	3.23%	1	14	0	16
15 Electroc./lightning	31	2	6.45%	0	0.00%	0	2	0	29
16 Eye problems	177	8	4.52%	2	1.13%	1	7	1	168
17 Falls	16,568	2245	13.55%	152	0.92%	96	2149	56	14,267
18 Headache	1606	277	17.25%	7	0.44%	4	273	3	1326
19 Heart probs/AICD.	3852	386	10.02%	42	1.09%	30	356	12	3454
20 Heat/cold exposure	57	24	42.11%	2	3.51%	2	22	0	33
21 Haemorrhage/lacer.	5092	547	10.74%	53	1.04%	25	522	28	4517
23 Overdose/poisoning	3269	1294	39.58%	167	5.11%	122	1172	45	1930
25 Psych./suicide attempt	5597	994	17.76%	59	1.05%	45	949	14	4589
26 Sick person	14,309	2269	15.86%	313	2.19%	154	2115	159	11,881
27 Stab/gunshot/penet.	215	8	3.72%	2	0.93%	1	7	1	206
28 Stroke	3932	1616	41.10%	186	4.73%	159	1457	27	2289
29 Traffic/transport.	1493	69	4.62%	11	0.74%	4	65	7	1417
30 Traumatic injuries	3388	436	12.87%	13	0.38%	5	431	8	2944
31 Unconscious/fainting	6635	3671	55.33%	308	4.64%	294	3377	14	2950
Total	109,678	19,359	17.65%	1833	1.67%	1282	18,077	551	89,768

Table 5. Measures of diagnostic accuracy, by MPDS chief complaint

MPDS chief complaint	Sensitivity as % (and 95% CI)	Specificity as % (and 95% CI)	PPV as % (and 95% CI)	χ^2 (PPV)	NPV as % (and 95% CI)	χ^2 (NPV)
01 Abdo. pain/problems	60.0 (32.3-83.7)	91.0 (90.2-91.7)	1.8 (0.8-3.3)	19.20	99.9 (99.7-100.0)	19.82
02 Allergies/envenom.	52.9 (27.8-77.0)	86.9 (85.3-88.5)	3.8 (1.7-7.0)	3.15	99.5 (99.0-99.8)	0.21
03 Animal bites/attacks	N/A	93.7 (86.8-97.6)	0.0 (0.0-45.9)	*	100.0 (95.9-100.0)	*
04 Assault/sexual assault	52.2 (30.6-73.2)	83.0 (81.4-84.6)	3.2 (1.7-5.6)	6.83	99.4 (98.9-99.7)	0.01
05 Back pain	0.0 (0.0-97.5)	95.5 (94.6-96.3)	0.0 (0.0-3.2)	7.94	100.0 (99.8-100.0)	12.61
06 Breathing problems	61.2 (55.5-66.7)	83.6 (82.9-84.2)	7.9 (6.9-9.1)	6.58	98.9 (98.7-99.1)	37.70
07 Burns/explosion	0.0 (0.0-84.2)	98.8 (96.5-99.7)	0.0 (0.0-70.8)	*	99.2 (97.1-99.9)	*
08 CO/Inh./HAZ./CBRN	100.0 (15.8-100.0)	72.0 (57.5-83.8)	12.5 (1.6-38.3)	*	100.0 (90.3-100.0)	*
10 Chest pain	50.0 (35.5-64.5)	93.8 (93.5-94.2)	2.5 (1.6-3.6)	28.46	99.8 (99.8-99.9)	49.47
11 Choking	50.0 (1.3-98.7)	91.4 (84.4-96.0)	10.0 (0.3-44.5)	*	99.0 (94.4-100.0)	*
13 Diabetic problems	96.9 (91.1-99.4)	36.0 (33.2-38.8)	10.9 (8.9-13.2)	25.64	99.3 (98.0-99.9)	0.06
14 Drown./diving/SCUBA	100.0 (2.5-100.0)	53.3 (34.3-71.7)	6.7 (0.2-31.9)	*	100.0 (79.4-100.0)	*
15 Electroc./lightning	N/A	93.5 (78.6-99.2)	0.0 (0.0-84.2)	*	100.0 (88.1-100.0)	*
16 Eye problems	50.0 (1.3-98.7)	96.0 (91.9-98.4)	12.5 (0.3-52.7)	*	99.4 (96.7-100.0)	*
17 Falls	63.2 (55.0-70.8)	86.9 (86.4-87.4)	4.3 (3.5-5.2)	19.98	99.6 (99.5-99.7)	11.34
18 Headache	57.1 (18.4-90.1)	82.9 (81.0-84.7)	1.4 (0.4-3.7)	12.01	99.8 (99.3-100.0)	3.24
19 Heart probs./AICD.	71.4 (55.4-84.3)	90.7 (89.7-91.6)	7.8 (5.3-10.9)	0.83	99.7 (99.4-99.8)	3.98
20 Heat/cold exposure	100.0 (15.8-100.0)	60.0 (45.9-73.0)	8.3 (1.0-27.0)	*	100.0 (89.4-100.0)	*
21 Haemorrhage/lacer.	47.2 (33.3-61.4)	89.6 (88.8-90.5)	4.6 (3.0-6.7)	3.72	99.4 (99.1-99.6)	0.00
23 Overdose/poisoning	73.1 (65.7-79.6)	62.2 (60.5-63.9)	9.4 (7.9-11.2)	16.48	97.7 (97.0-98.3)	90.67
25 Psych./suicide attempt	76.3 (63.4-86.4)	82.9 (81.8-83.8)	4.5 (3.3-6.0)	7.06	99.7 (99.5-99.8)	7.10
26 Sick person	49.2 (43.5-54.9)	84.9 (84.3-85.5)	6.8 (5.8-7.9)	0.10	98.7 (98.5-98.9)	100.25
27 Stab/gunshot/penet.	50.0 (1.3-98.7)	96.7 (93.3-98.7)	12.5 (0.3-52.7)	*	99.5 (97.3-100.0)	*
28 Stroke	85.5 (79.6-90.2)	61.1 (59.5-62.7)	9.8 (8.4-11.4)	27.04	98.8 (98.3-99.2)	11.80
29 Traffic/transport.	36.4 (10.9-69.2)	95.6 (94.4-96.6)	5.8 (1.6-14.2)	0.08	99.5 (99.0-99.8)	0.33
30 Traumatic injuries	38.5 (13.9-68.4)	87.2 (86.1-88.3)	1.1 (0.4-2.7)	21.14	99.7 (99.5-99.9)	5.60
31 Unconscious/fainting	95.5 (92.5-97.5)	46.6 (45.4-47.9)	8.0 (7.2-8.9)	11.41	99.5 (99.2-99.7)	0.93
Total	69.9 (67.8-72.0)	83.2 (83.0-83.5)	6.6 (6.3-7.0)	217.64	99.4 (99.3-99.4)	355.09

* χ^2 values not calculated for rows with expected values <1

does not understand the initial question) 'is s/he responding appropriately?' in a system using MPDS for triage, achieved better caller understanding (28). Criteria based dispatch, another triage algorithm used internationally, has the question 'can the patient respond to you and follow simple commands?' (29). It may be that such wording yields more accurate responses, but ultimately none of these questions have been validated. Further research is suggested into the most linguistically optimal questioning to achieve clinically useful answers from the caller.

This study fills an important knowledge gap (18). The two previous studies (19,20) examining the accuracy of conscious state determination in dispatch were based on the distinction between conscious versus unconscious patients. However, given that alertness among conscious patients is also a key component of emergency medical dispatch systems such as the MPDS, it is essential to understand its accuracy. The inventor of the MPDS algorithm has described 'determining true non-alertness' as one of the holy grails requiring further research (30,31). To the authors' knowledge, this study is the first to undertake a system-wide analysis of this issue.

Limitations

The study compared the determination of a patient's conscious state at the time of the emergency call to their conscious state when attended by paramedics. There is necessarily a time delay between these two measures, during which a patient could deteriorate or recover. It is not possible to know the patient's true conscious state at the exact time of the call; therefore, this study considers the accuracy as a predictor of what will be found on paramedic arrival.

This study compared the reported conscious state of the patient as selected by the EMD at the time of the call, however, it did not analyse audio of call recordings. This could be a valuable avenue for future research to further inform what is said by callers and how this relates to the patient's condition. With the scale of data in this study it was not practical to determine the relationship between caller and patient for individual calls and how this relates to accuracy, however this could also be an informative avenue for future research.

Conclusion

This study found that dispatch determination of patient altered conscious state yields a high NPV but a low PPV, with more than 10 times as many cases dispatched as not alert than patients who are not alert on scene. Despite this, the system did not achieve high sensitivity, with three out of every 10 patients who were not-alert on the scene being dispatched as alert. There were significant differences in the positive and negative predictive values between different chief complaints. Further research is suggested into the factors that affect the accuracy of EMD determination of patient conscious state, including the phrasing used by callers and EMDs.

Competing interests

The authors of this paper report no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement. JB and AW are employed full time by SJWA as ambulance paramedic and operations manager respectively. JF receives partial research funding from SJWA, and both JF and SB have adjunct research appointments with SJWA.

References

1. Andrew E, Jones C, Stephenson M, et al. Aligning ambulance dispatch priority to patient acuity: a methodology. Emerg Med Australas 2019;31:405-10. doi: 10.1111/1742-6723.13181
2. Eastwood K, Morgans A, Smith K, et al. A novel approach for managing the growing demand for ambulance services by low-acuity patients. Aust Health Rev 2016;40:378-84. doi: 10.1071/ah15134
3. Bohm K, Kurland L. The accuracy of medical dispatch - a systematic review. Scand J Trauma Resusc Emerg Med 2018;26:94. doi: 10.1186/s13049-018-0528-8
4. Yancey A, Clawson J. EMD position paper resource document. Ann Emerg Dispatch Response 2014;2(2).
5. Ball SJ, Williams TA, Smith K, et al. Association between ambulance dispatch priority and patient condition. Emerg Med Australas 2016;28:716-24.
6. Feldman MJ, Verbeek PR, Lyons DG, et al. Comparison of the medical priority dispatch system to an out-of-hospital patient acuity score. Acad Emerg Med 2006;13:954-60. doi: 10.1197/j.aem.2006.04.018
7. Hodell EM, Sporer KA, Brown JF. Which emergency medical dispatch codes predict high prehospital nontransport rates in an urban community? Prehosp Emerg Care 2014;18:28-34. doi: 10.3109/10903127.2013.825349
8. Hoikka M, Länkimäki S, Silfvast T, Ala-Kokko TI. Medical priority dispatch codes - comparison with national early warning score. Scand J Trauma Resusc Emerg Med 2016;24:142. doi: 10.1186/s13049-016-0336-y
9. Neely KW, Eldurkar JA, Drake MER. Do emergency medical services dispatch nature and severity codes agree with paramedic field findings? Acad Emerg Med 2000;7:174-80.
10. Sporer KA, Craig AM, Johnson NJ, Yeh CC. Does emergency medical dispatch priority predict delphi process-derived levels of prehospital intervention? Prehosp Disaster Med 2010;25:309-17.
11. Sporer KA, Youngblood GM, Rodriguez RM. The ability of emergency medical dispatch codes of medical complaints to predict ALS prehospital interventions. Prehosp Emerg Care 2007;11:192-8. doi: 10.1080/10903120701205984
12. Mosley I, Morphet J, Innes K, Braitberg G. Triage assessments and the activation of rapid care protocols for acute stroke patients. Australas Emerg Nurs J 2013;16:4-9. doi: https://doi.org/10.1016/j.aenj.2012.12.002
13. American College of Surgeons, Committee on Trauma. Advanced trauma life support: student course manual. Chicago, IL2018.

14. Umpierrez G, Korytkowski M. Diabetic emergencies - ketoacidosis, hyperglycaemic hyperosmolar state and hypoglycaemia. Nat Rev Endocrinol 2016;12:222-32. doi: http://dx.doi.org/10.1038/nrendo.2016.15
15. Kelly C, Upex A, Bateman D. Comparison of consciousness level assessment in the poisoned patient using the alert/verbal/painful/unresponsive scale and the Glasgow Coma Scale. Ann Emerg Med 2004;44:108-13.
16. Australian Government Department of Health and Ageing. Emergency triage education kit. Canberra: DoHA; 2009. Available at: https://acem.org.au/getmedia/c9ba86b7-c2ba-4701-9b4f-86a12ab91152/Triage-Education-Kit.aspx
17. International Academy of Emergency Medical Dispatch. Medical priority dispatch system QA guide v13. Salt Lake City: Priority Dispatch Corporation; 2016.
18. Belcher J, Finn J, Whiteside A, Ball SJ. Accuracy of call-taker assessment of patient level of consciousness: a systematic review. Australasian Journal of Paramedicine 2020;17. doi:10.33151/ajp.17.741
19. Bach A, Christensen EF. Accuracy in identifying patients with loss of consciousness in a police-operated emergency call centre – first step in the chain of survival. Acta Anaesthesiol Scand 2007;51:742-6. doi:10.1111/j.1399-6576.2007.01310.x
20. Radonić J, Gnjidić M, Matijanec M, Hochstädter D, Jasprica-Hrelec V. What is not revealed in the telephone call reporting “unconsciousness”. Lijec Vjesn. 1995;117(Suppl 2):68-70.
21. Australian Bureau of Statistics. Regional population growth, Australia, 2017-18. Canberra: ABS; 2019.
22. St John Western Australia. Annual report 2018-2019. Available at: https://stjohnwa.com.au/docs/default-source/corporate-publications/annual-report-2019_v11_web.pdf?sfvrsn=6
23. Queensland Ambulance Service. Neurological assessment. Clinical Practice Manual 2016; p. 431-3.
24. American College of Surgeons Committee on Trauma. Advanced life support course for physicians. Chicago, IL: American College of Surgeons; 1993.
25. Clopper C, Pearson E. The use of confidence or fiducial limits illustrated in the case of the binomial. Biometrika 1934;26:404-13.
26. Yates D, Moore D, McCabe G. The practice of statistics. 1st edn. New York: W.H. Freeman; 1999.
27. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974;2:81-4.
28. Pereira VdC, Scott S, Nakano MU, et al. Caller’s ability to understand “responding normally” vs. “completely alert” key question in a Brazilian Portuguese version of an emergency medical dispatch protocol. Ann Emerg Dispatch Response 2019;7(2).
29. King County Emergency Medical Services Division. Criteria based dispatch: emergency medical dispatch guidelines 2010. Available at: www.emsonline.net/assets/CriteriaBasedDispatchGuidelines-Rev2010.pdf
30. Frazier A. Completely alert? The Journal of Emergency Dispatch. 2019. Available at: https://iaedjournal.org/completely-alert/
31. Clawson J. The holy grail of emergency medical dispatching. Ann Emerg Dispatch Response 2013;1(1).