Concussion assessment in the emergency department: a preliminary study for a quality improvement project

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ABSTRACT

Background In sport, concussion is assessed using the Sports Concussion Assessment Tool (SCAT) 5 and managed with return to play guidelines. Similar, user-friendly tools are rarely, if ever, used in the emergency department (ED).

Objectives To evaluate a modified concussion assessment tool designed for the ED (ED-CAT) in patients presenting with a head injury and to identify variables that predict 30-day reattendance.

Methods A preliminary, prospective, evaluation in a quality improvement project was conducted in one hospital in South Wales. Patients were recruited if they were over 13 years, and either did not have an ED-CT head scan or had a scan with no acute changes. The primary outcome was 30-day reattendance.

Results 40 patients were recruited, 18 of whom had a CT scan. 37 were discharged on the same day with advice, two discharged the next day and one was admitted. Three (7.5%) patients reattended the department. Predictors of reattendance were headache score (median 3.0 vs 5.0; p<0.05), pressure in head score (2.0 vs 5.0; p<0.05), nausea/vomiting score (1.0 vs 3.0; p<0.05), dizziness score (1.0 vs 4.0; p<0.05), blurred vision score (0 vs 4.0; p<0.01), balance problems score (0 vs 4.0; p<0.05), sensitivity to light and confusion score (0 vs 4.0; p<0.01), orientation score (1.0 vs 0; p<0.05) and immediate memory score (5.0 vs 4.0; p<0.05).

Conclusions Key symptoms and signs predicted 30-day reattendance. The ED-CAT requires validation and refinement in a larger population to produce a short, practical, user-friendly, relevant tool for ED head injury assessment.

INTRODUCTION

Concussion is one of the complications of a head injury, a common presentation to the emergency department (ED).1 Evidence in the UK is lacking, but the presentations of concussion to the ED in America has been estimated to be over 150 000 annually.2

Another study reports that around 100 000 patients per year present to the ED in just the 8–19 age group in America.3 In sport, where there is more evidence, incidence is highest in rugby and ice hockey.1

The operational definition of concussion as the ‘immediate and transient symptoms of mild traumatic brain injury’ but this has drawn criticism due to a lack of accuracy.3 The Concussion in Sport Group (CISG)6 defines concussion as a ‘complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces’. This may be due to a blow to the head or body that leads to the rapid development of neurological impairment that does not last long and resolves of its own accord.6 The acute symptoms are less likely to be due to structural injury and therefore are associated with grossly normal neuroimaging. However, concussion may cause neuropathological changes.6 The clinical and cognitive symptoms (of which loss of consciousness may be included) of concussion and its sequelae typically resolve gradually.5 The initial effects of concussion cover a large spectrum of symptoms.7 The CISG7 list these over certain ‘clinical domains’. These include somatic/cognitive/emotional symptoms, physical signs such as loss of consciousness, balance impairment, behavioural changes, cognitive impairment and sleep/wake disturbance.7 The CISG advise that concussion should be suspected if any of the symptoms are present, but acknowledge that they are non-specific.7

What are the new findings?

► A tool designed for concussion assessment within the emergency department (ED) was able to be developed by modifying the Sports Concussion Assessment Tool 5.

► Key symptoms and traits on the tool were able to identify reattenders to the ED.

How might it impact on clinical practice in the near future

► With further development, this tool may be used in the ED to identify those suffering a more severe concussive episode.
In sport, concussion is routinely assessed using the Sports Concussion Assessment Tool (SCAT) which has been adopted by many sporting bodies. The SCAT requires a clinical judgement to be made by the examining clinician based on the scores from each section of the assessment; it does not simply identify those who are concussed. Recommendations for sports-related concussion management have been summarised by the CISG in the graduated Return to Play guidelines (see online supplementary appendix 2). The National Institute of Clinical Excellence (NICE) in 2014 published detailed recommendations for patients presenting to the ED with a head injury. However, concussion receives little attention. The main assessment in the ED is to identify if the patient needs a CT head scan according to the Canadian CT head rule. There is no routinely used, formal assessment for concussion. The mainstay of management for concussion is discharge with advice regarding red flag symptoms, head injury leaflets and no follow-up. Concussion advice in the ED is minimal compared with Return to Play guidance for athletes. This may partly be due to time pressure and partly due to prioritisation perspective, as the priority for ED is to rule out life-threatening events.

It is important not to miss concussion. Athletes who have had a concussive episode are at higher risk of re-injury, further concussive episodes in the same season, second impact syndrome, postconcussion syndrome and long-term neuropsychological effects. Repeated concussions can lead to neurodegenerative changes, a disease process known as chronic traumatic encephalopathy. Those that return to normal activities too early are at risk of these complications.

There is little evidence about concussion in the general public or in recreational sport, which also means it is often poorly managed in these populations. Data collection systems need improving in the community and in the ED. This could be achieved by introducing the SCAT into the ED as an adjunct to the clinical diagnosis of concussion. However, the SCAT is long and cumbersome and unlikely to be adopted in busy EDs. However, a shorter, simpler, evidence-based assessment tool could be adopted.

There is currently no generally well-accepted, objective tool for recognising concussion in the ED. Tools have been developed, such as the Acute Concussion Evaluation form, but these have not been adopted in the ED setting. The objectives of this study, in patients presenting to the ED with a head injury, are to evaluate a potential ED concussion assessment tool investigating which variables predicted 30-day reattendance. This tool may help identify those patients with a more severe concussion who may benefit from follow-up.

METHODS

Design, setting and participants
As part of a quality improvement programme to improve head injury and concussion assessment in the ED, we have conducted a preliminary, prospective, single-centre study to assess concussion in the ED. Participants were recruited if presenting to the ED of a major teaching hospital in South Wales with a head injury from 25th November 2017 to 22nd January 2018. To be recruited, patients had to present between 08:00 and 17:00 Monday–Friday, when the primary researcher was present. Patients were eligible if aged ≥13 years and either not requiring a CT head scan or with a negative CT scan. Patients were excluded if they had acute changes on CT scan. The methodology of the study is demonstrated in figure 1. The model and cycle specific for this project is shown in online supplementary appendix 4.

The assessment tool and data collection
The SCAT form was modified in order to produce a suitable form for use in the ED—the Emergency Department Concussion Assessment Tool (ED-CAT; see online supplementary appendix 3). The sections used for immediate/on field assessment from SCAT were removed and some sections were shortened. It still retains several sections, which include patient details, orientation, immediate
| Section | Name                        | Summary                                                                 | Maximum score | How scoring works                        |
|---------|-----------------------------|-------------------------------------------------------------------------|---------------|------------------------------------------|
| 1       | Patient details/background  | Identifies cause, time and date of injury and any risk factors for delayed recovery such as previous concussions. | –             | –                                        |
| 2       | Orientation                 | Assesses patients’ orientation to time and date. One point given for each correct answer. | 5             | Higher score indicates better orientation. |
| 3       | Immediate memory            | Asks patient to remember and say five words, which are read out to them three times. One point given for each word remembered. | 15            | Higher score indicates better memory.     |
| 4       | Symptom screen              | Assesses number of symptoms and severity of each symptom experienced, out of 6, by the patient and if these are worse during physical or mental activity. | Number of symptoms=22. | Higher score indicates more severe symptoms. |
|         |                              | Symptom severity score=132.                                              |               |                                          |
| 5       | Balance examination         | Assesses patients’ ability to stand on both feet, on just their weaker foot and in a tandem stance with their eyes closed and hands on hips for 10 s, as well as performing tandem gait over 3 m. Patients given a score out of 10 for each exercise and docked a point for each error made. | 40            | Higher score indicates better balance.    |
| 6       | Delayed recall              | Asks patient to recall the five words repeated to them during the immediate memory section. One point given for each word remembered. | 5             | Higher score indicates better memory.     |

Outcomes and follow up
The primary outcome for this study was 30-day reattendance to the ED. This was achieved by scanning the online patient records. Correlations were also analysed between the ED-CAT scores and likelihood of requiring a CT scan.

Statistical analysis
The data collected was analysed using the Mann-Whitney U test, a univariate non-parametric analysis. IBM SPSS Statistics (IBM Corp. Released 2015. IBM SPSS Statistics for Mac, V.23.0. Armonk, New York: IBM Corp.) and MedCalc (MedCalc Software, V.15.8, Ostend, Belgium) were used.

RESULTS
A total of 40 patients were recruited for the study. All 40 were followed up using online patient records. Patient flow through the study is demonstrated in figure 1.

Baseline characteristics, scores on ED-CAT and hospital management
The baseline characteristics of all 40 participants are shown in table 2, as well as the total scores for each section on the ED-CAT form.

Primary outcome—30-day reattendance
Of the 40 patients, three (7.5%) reattended the ED within 30 days of their initial assessment. Two patients reattended once and one reattended twice. This patient first reattended the same day due to vomiting and returned 28 days later due to dizziness. The reason for the other two participants reattending was because of worsening symptoms and the other started to develop dysphagia and right lower limb paresis and paraesthesia. This patient did not have a CT head scan initially but did so on their second attendance (as well as a CT cervical spine scan) but it showed no acute changes. They were admitted to hospital for 7 days before their symptoms cleared and they were discharged with concussive trauma.

Participant demographics, total scores for each section on the ED-CAT and management in the ED is shown in table 3 and the individual breakdown of each section on the ED-CAT is shown in table 4, compared with whether they reattended within 30 days.

The sections on the ED-CAT, which showed a significant difference in medians between reattenders and non-reattenders, were the orientation total score (step 2), orientation to date and time, one of the immediate memory trials, eight of the 22 symptoms and the sum of symptoms severity in step 4. The eight symptoms were headache, pressure in head, nausea or vomiting, dizziness, light-headedness, confusion, memory, balance and pain.

| Table 1 Summary of each section of the Emergency Department Concussion Assessment Tool |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Section | Name                        | Summary                                                                 | Maximum score | How scoring works                        |
|---------|-----------------------------|-------------------------------------------------------------------------|---------------|------------------------------------------|
| 1       | Patient details/background  | Identifies cause, time and date of injury and any risk factors for delayed recovery such as previous concussions. | –             | –                                        |
| 2       | Orientation                 | Assesses patients’ orientation to time and date. One point given for each correct answer. | 5             | Higher score indicates better orientation. |
| 3       | Immediate memory            | Asks patient to remember and say five words, which are read out to them three times. One point given for each word remembered. | 15            | Higher score indicates better memory.     |
| 4       | Symptom screen              | Assesses number of symptoms and severity of each symptom experienced, out of 6, by the patient and if these are worse during physical or mental activity. | Number of symptoms=22. | Higher score indicates more severe symptoms. |
|         |                              | Symptom severity score=132.                                              |               |                                          |
| 5       | Balance examination         | Assesses patients’ ability to stand on both feet, on just their weaker foot and in a tandem stance with their eyes closed and hands on hips for 10 s, as well as performing tandem gait over 3 m. Patients given a score out of 10 for each exercise and docked a point for each error made. | 40            | Higher score indicates better balance.    |
| 6       | Delayed recall              | Asks patient to recall the five words repeated to them during the immediate memory section. One point given for each word remembered. | 5             | Higher score indicates better memory.     |
Table 2  Participant’s characteristics*  

| Variable                                              | Participants (n=40) |
|-------------------------------------------------------|---------------------|
| Age, mean (SD), years                                 | 45.23 (24.97)       |
| Male                                                  | 19 (47.5)           |
| Time between injury and assessment in hospital, mean (SD), hours | 45.15 (121.70)     |
| Sports-related head injuries                         | 5 (12.5)            |
| Number of previous concussion, mean (SD)             | 0.35 (0.74)         |
| Hospitalised because of HI in the past               | 6 (15.0)            |
| Diagnosed or treated for headache disorder or migraines | 11 (27.5)         |
| Diagnosed with learning disabilities or dyslexia     | 2 (5.0)             |
| Diagnosed with ADHD                                  | 0 (0.0)             |
| Diagnosed with depression, anxiety or sleep disorder | 8 (20.0)            |
| Currently prescribed medication                       | 24 (60.0)           |
| Cause of HI                                           |                     |
| Direct blow                                           | 18 (45.0)           |
| Fall                                                  | 19 (47.5)           |
| Motor vehicle collision                               | 3 (7.5)             |
| Step 2 score: orientation (0–5), mean (SD)           | 4.65 (0.62)         |
| Step 3 score: immediate memory (0–15), mean (SD)     | 13.58 (2.06)        |
| Step 4 score: total number of symptoms (0–22), mean (SD) | 11.13 (6.60)      |
| Step 4 score: symptom severity score (0–132), mean (SD) | 35.93 (28.12)      |
| Symptoms worse with physical activity                 |                     |
| Yes                                                   | 5 (12.5)            |
| No                                                    | 7 (17.5)            |
| Unknown                                               | 28 (70.0)           |
| Symptoms worse with mental activity                   |                     |
| Yes                                                   | 19 (47.5)           |
| No                                                    | 12 (30.0)           |
| Unknown                                               | 9 (22.5)            |
| Step 5 score: balance examination (0–40), mean (SD)   | 24.18 (15.18)       |
| Step 6 score: delayed recall (0–5), mean (SD)         | 3.03 (1.70)         |
| Investigated with a CT scan in ED                     | 18 (45.0)           |
| Management of patient                                 |                     |
| Discharged home same day                              | 37 (92.5)           |
| Discharged home next day                              | 2 (5.0)             |
| Admitted                                              | 1 (2.5)             |
| Patients reattending the ED within 30 days             | 3 (7.5)             |

*Values are number (%) of participants unless stated otherwise. If a mean is shown, in brackets is the SD. In brackets after variables that are scored are the potential scores available for that section.

ADHD, attention deficit hyperactivity disorder; ED, emergency department; HI, head injury.

dizziness, blurred vision, balance problems, sensitivity to light and confusion.

Correlations between variables—ED-CAT scores and CT scan  
Of the 40 patients, 18 were investigated with a CT scan in the ED as per the NICE criteria, none of which had acute changes. When comparing total scores on each section of the ED-CAT and whether or not the patient had the scan showed only one significant result, the balance examination score (step 5). This showed that those who met the criteria scored significantly lower and therefore demonstrated worse balance (median scores of 14.00 vs 35.00).

Management in the ED  
Thirty-seven patients were discharged from the ED the same day with head injury advice and a leaflet. Two patients were discharged the next day from the ED. One patient was admitted for 2 weeks due to frailty. Six patients were unable to perform the balance examinations (step 5), either due to unsteadiness or dizziness, and one patient had sustained an undisplaced ankle fracture as well as a head injury in a motor vehicle collision. These patients scored 0 on the balance examinations as a result.

DISCUSSION  
This prospective preliminary quality improvement project is one of the first studies looking into concussion assessment in an ED setting using an appropriate tool (the ED-CAT) modified from the SCAT5. This study has demonstrated that scores on certain sections of the ED-CAT were more likely to correlate to a reattendance to the department within 30 days of the original presentation. This may suggest that the concussion experienced by these patients was more severe.

Quality improvement projects are continuously improving processes used to achieve high quality care. They involve several elements which are summarised by the model of improvement and plan, do, study, act cycle. They tend to be more effective than traditional audits as a series of interventions and adaptations can be assessed quickly. This project is the first initiative in the quality improvement process aiming to improve concussion assessment in the ED. The cycle (see online supplementary appendix 4) allows for further improvement to be made specifically, to validate the form and test the form using other clinical outcomes (figure 2).

The ED-CAT is one of the first forms to aid the assessment of concussion in the ED. It does not include the immediate acute tests that are present in the SCAT5 such as the ‘on field assessment’. This makes it suitable to use when patients have self-presented to an ED sometime after their original injury. Some sections of the SCAT5 were shortened, so that ED-CAT was suitable to use in a busy ED where assessing patients efficiently and safely discharging them is critical. The ED-CAT consists of five scoring sections which are orientation, immediate memory, symptom screen (which is split into number of...
## Table 3: Summary of patient demographics, scores on Emergency Department Concussion Assessment Tool and management in the emergency department*

| Variable                                                                 | Reattended (n=3)       | No reattendance (n=37) | P value |
|--------------------------------------------------------------------------|------------------------|------------------------|---------|
| Age, median (IQR), years                                                | 53                     | 36.00 (23.75–68.00)    | 0.6812  |
| Male                                                                     | 2 (66.7)               | 17 (45.9)              |         |
| Time between injury and assessment, median (IQR), hours                 | 15.83                  | 15.50 (3.50–37.54)     | 0.719   |
| Sports-related HIs                                                       | 0 (0.0)                | 5 (13.5)               |         |
| Number of previous concussions, median (IQR)                           | 0 (0.0)                | 0.00 (0.00–0.50)       | 1       |
| Hospitalised for a HI in the past                                       | 0 (0.0)                | 6 (16.2)               |         |
| Diagnosed or treated for headache disorder or migraines                 | 1 (33.3)               | 10 (27.0)              |         |
| Diagnosed with learning disabilities or dyslexia                       | 0 (0.0)                | 2 (5.4)                |         |
| Diagnosed with ADHD                                                     | 0 (0.0)                | 0 (0.0)                |         |
| Diagnosed with depression, anxiety or sleep disorder                    | 0 (0.0)                | 8 (21.6)               |         |
| Currently prescribed medication                                         | 2 (66.7)               | 22 (59.5)              |         |
| Cause                                                                   |                        |                        |         |
| Direct blow                                                             | 1 (33.3)               | 17 (45.9)              |         |
| Fall                                                                    | 1 (33.3)               | 18 (48.6)              |         |
| Motor vehicle collision                                                  | 1 (33.3)               | 2 (5.4)                |         |
| Step 2 score—orientation (0–5), median (IQR)                           | 3                      | 5.00 (4.75–5.00)       | 0.0451  |
| Step 3 score—immediate memory (0–15), median (IQR)                     | 13                     | 14.00 (13.00–15.00)    | 0.365   |
| Step 4 score—number of symptoms (0–22), median (IQR)                   | 17                     | 9.00 (4.50–16.50)      | 0.142   |
| Step 4 score—symptom severity (0–132), median (IQR)                    | 67                     | 26.00 (9.75–51.00)     | 0.04    |
| Step 5 score—balance examinations (0–40), median (IQR)                 | 0                      | 31.00 (10.00–37.50)    | 0.328   |
| Step 6 score—delayed recall (0–5), median (IQR)                        | 2                      | 3.00 (2.00–4.50)       | 0.559   |
| Investigated with a CT head scan                                       | 2 (66.7)               | 16 (43.2)              |         |
| Management                                                              |                        |                        |         |
| Discharged home same day                                                | 3 (100)                | 34 (91.9)              |         |
| Discharged home next day                                                | 0 (0)                  | 2 (5.4)                |         |
| Admitted                                                                | 0 (0)                  | 1 (2.7)                |         |

*Values shown is number (%) of participants unless stated otherwise. If a median is shown, in brackets is the IQR. No IQR could be generated for reattenders as the sample was too small. In brackets after variables that are scored are the potential scores available for that section.

ADHD, attention deficit hypersensitivity disorder; HI, head injury.

Our study has showed that the orientation score, symptom severity score and parts of the symptom and immediate memory sections were able to predict worse outcomes. Patients who reattended the ED within 30 days were significantly more likely to have worse orientation overall as well as worse scores for orientation to date and time; remember less words on the third trial of the immediate memory test (4 words vs 5); be experiencing more severe symptoms of headache, pressure in head, nausea or vomiting, dizziness, blurred vision, balance problems, sensitivity to light and confusion and have a worse overall symptom severity score (67 compared with 26). As these sections were able to predict 30-day reattendance, they may be able to predict worse concussive syndromes. Emergency physicians may be able to use the form to is. It is recommended for future studies to revert back to modified BESS employed by the SCAT5.
Table 4  The individual breakdown of participant scores on the Emergency Department Concussion Assessment Tool*

| Variable                          | Reattended   | No reattendance | P value |
|----------------------------------|--------------|-----------------|---------|
|                                  | (n=3)        | (n=37)          |         |
| Step 2—orientation               | –            | –               | –       |
| Month (0–1)                       | 1            | 1.00 (1.00–1.00)| 1       |
| Date (0–1)                        | 0            | 1.00 (1.00–1.00)| 0.01    |
| Day (0–1)                         | 1            | 1.00 (1.00–1.00)| 0.776   |
| Year (0–1)                        | 1            | 1.00 (1.00–1.00)| 1       |
| Time (0–1)                        | 0            | 1.00 (1.00–1.00)| 0.021   |
| Step 3—immediate memory          | –            | –               | –       |
| First trial (0–5)                 | 5            | 4.00 (4.00–5.00)| 0.89    |
| Second trial (0–5)                | 4            | 5.00 (5.00–5.00)| 0.058   |
| Third trial (0–5)                 | 4            | 5.00 (5.00–5.00)| 0.0185  |
| Step 4—symptom screen            | –            | –               | –       |
| Headache (0–6)                    | 5            | 3.00 (1.75–4.00)| 0.0492  |
| Pressure in head (0–6)            | 5            | 2.00 (1.00–4.00)| 0.0298  |
| Neck pain (0–6)                   | 3            | 1.00 (0.00–3.00)| 0.0611  |
| Nausea or vomiting (0–6)          | 3            | 1.00 (0.00–2.00)| 0.0145  |
| Dizziness (0–6)                   | 4            | 1.00 (0.00–3.00)| 0.0158  |
| Blurred vision (0–6)              | 4            | 0.00 (0.00–0.25)| 0.0037  |
| Balance problems (0–6)            | 4            | 0.00 (0.00–2.25)| 0.0193  |
| Sensitivity to light (0–6)        | 4            | 0.00 (0.00–1.25)| 0.0017  |
| Sensitivity to noise (0–6)        | 0            | 0.00 (0.00–1.25)| 0.8773  |
| Feeling slowed down (0–6)         | 4            | 2.00 (0.00–4.00)| 0.0981  |
| Feeling like in a fog (0–6)       | 3            | 0.00 (0.00–3.00)| 0.3786  |
| Don’t feel right (0–6)            | 4            | 3.00 (0.75–4.00)| 0.5684  |
| Difficulty concentrating (0–6)    | 4            | 2.00 (0.00–4.00)| 0.3988  |
| Difficulty remembering (0–6)      | 2            | 0.00 (0.00–2.00)| 0.3926  |
| Fatigue or low energy (0–6)       | 3            | 2.00 (0.00–4.00)| 0.1438  |
| Confusion (0–6)                   | 4            | 0.00 (0.00–2.00)| 0.003   |
| Drowsiness (0–6)                  | 5            | 2.00 (0.00–3.25)| 0.2178  |
| More emotional (0–6)              | 3            | 1.00 (0.00–3.00)| 0.0535  |
| Irritability (0–6)                | 4            | 0.00 (0.00–2.00)| 0.1241  |
| Sadness (0–6)                     | 0            | 0.00 (0.00–1.00)| 0.9262  |
| Nervous or anxious (0–6)          | 0            | 0.00 (0.00–2.25)| 0.53    |
| Trouble falling asleep (0–6)      | 0            | 0.00 (0.00–2.25)| 0.2958  |

Symptoms were worse with physical activity, number (%)

| Yes | 1 (33.3) | 4 (10.8) | – |
| No  | 0 (0.0)  | 7 (18.9) | – |
| Unknown | 2 (66.7) | 26 (70.3) | – |

Symptoms were worse with mental activity, number (%)

| Yes | 2 (66.7) | 17 (45.9) | – |
| No  | 0 (0.0)  | 12 (32.4) | – |
| Unknown | 1 (33.3) | 8 (21.6) | – |

Step 5—balance examination

| Double leg stance (0–10) | 0 | 10.00 (10.00–10.00) | 0.074 |
| Single leg stance (0–10) | 0 | 5.00 (0.00–8.00)   | 0.731 |

Continued
Table 4 Continued

| Variable           | Reattended  | No reattendance | P value |
|--------------------|-------------|-----------------|---------|
| Tandem stance (0–10) | 0           | 7.00 (0.00–10.00) | 0.319   |
| Tandem gait (0–10)  | 0           | 10.00 (0.00–10.00) | 0.396   |

*Values are medians (IQR) unless stated otherwise. No IQR could be generated for reattenders as the sample was too small. In brackets after variables that are scored are the potential scores available for that section.

identify these patients and modify their management plan to reduce the chance of them reattending.

In a previous systematic review on concussion assessment involving 33 studies and 2416 athletes, it was found that a symptoms-based approach is best when trying to identify sports-related concussion.23 Symptoms most frequently reported were ‘headache’, ‘fatigue’, ‘difficulty concentrating’ and ‘dizziness’; two of these symptoms predicted reattendance in our study. They concluded that acute assessment of sports-related concussion should involve neurological, vestibular, ocular motor, visual, neurocognitive, psychological and cervical aspects,23 which the ED-CAT attempts to do in conjunction with a history and full examination. Hänninen et al.,24 in a prospective cohort study of 27 professional ice hockey players, investigated the validity of the SCAT3. They reported that the symptom section of the SCAT3 was the most sensitive in identifying concussed athletes immediately post-injury and the most common symptoms reported were ‘don’t feel right’, ‘headache’ and ‘pressure in head’.24 An observational case series into the SCAT3 involving 167 patients found that common symptoms reported by athletes included ‘headache’, ‘balance problems’ and ‘don’t feel right’.25 The symptoms most frequently reported in these three studies show some resemblance to the significant findings in this study, with headache being a common theme. However, some caution must be used as these papers investigated concussion assessment immediately postinjury in athletes. Our study investigated sports and non-sports related concussion with a mean time period between injury and assessment being 45 hours; so, these two populations are not completely comparable. It is worth noting that only five of the 40 cases in this study were sports related.

Our secondary analysis interestingly showed a significant correlation between poor balance and meeting the criteria for a CT head scan. However, it is unlikely that this is going to affect practice as there is already a well-accepted criteria in place for assessing the need for a CT scan post head injury.10 11

Strengths and limitations

The primary strength of this quality improvement project is the development of a form that aids concussion...
It is likely that the current ED-CAT is still too long for implementation in most EDs. Larger studies will confirm those variables that contribute little to concussion assessment in the ED, which can be removed.

Another simple initiative the ED can employ is better discharge advice for those suspected with concussion on top of a head injury leaflet. As we explored earlier, discharge advice for concussion is minimal. A specific concussion leaflet to be given out in the ED explaining what is it and how to effectively manage the symptoms including return to work or study guidance, similar to the Return to Play guidelines for athletes, may help standardise discharge advice.

**CONCLUSION**

This quality improvement project has shown that key symptoms, signs and traits highlighted by the ED-CAT were more sensitive to 30-day reattendance in patients over the age of 13 presenting to the ED with a head injury. These sections showed reattenders to have worse orientation, immediate memory and symptoms. These sections therefore may help identify those suffering from a more severe concussion to emergency physicians assessing them in the ED. These patients could then benefit from an altered management plan to aid their recovery from concussion.

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