AUT TRAUMATIC BRAIN INJURY NETWORK

COUNTIES MANUKAU HEALTH

Report on the Preliminary Results from BIST-Extended Pilot Study in Counties Manukau District Health Board

Executive Summary

Why was this work needed?

Nearly one third of patients (31%) present to the Emergency Department (ED) for medical assessment and treatment following a suspected mild traumatic injury or concussion (mTBI, unpublished ACC data). However, how mTBis are assessed and managed in the ED is highly variable across NZ;

- 1 in 5 (23%) mTBI cases are missed (not coded accurately) due to focussing on more acute or life threatening injuries.[1]
- Recommended assessment tools are used inconsistently and decision making regrading which patients to refer to which service varies considerably.
- There are psychometric (measurement properties) and clinical utility problems with current recommended assessment tools. For example, the Rivermead Post-Concussion Symptom Scale is not designed for clinical use in the acute setting, is not able to monitor recovery well over time,[2] contains complex language, has little evidence of cultural responsivity, has complex scoring, and does not actively support health care pathway decision making.
- The naming of post-traumatic amnesia (PTA) assessment tools has also caused confusion resulting in the wrong tool being used.
- Only 36% of patients receive follow up care after discharge from ED.[1]

A new tool called the Brain Injury Screening Tool (BIST) was developed by an interdisciplinary group to support the screening of symptoms for suspected TBI across the health sector and provide guidance on health care pathway decision making. The tool has embedded, evidence-based risk factors of poor recovery indicating patients who may need a referral to concussion services. Cultural engagement occurred throughout its development to ensure cultural responsiveness and to reduce current inequities. A new component (BIST-Extended) was developed to assess PTA specifically for the ED setting.

What did we do?

We tested the feasibility, and clinical utility, of the BIST symptom scale and BIST-Extended PTA component. Adults and Children (over 8 years of age) who presented to the Middlemore ED (Counties-Manukau District Health Board) between 27/12/2022 and 22/02/2022 with a suspected mild TBI were eligible to take part in the feasibility study. The BIST symptom scale and the BIST-Extended PTA component were delivered by a Registered Nurse alongside current recommended assessments of Rivermead Post-Concussion Symptom Scale and the Abbreviated Westmead (A-Westmead) across different days/shifts in the ED.

What did we find?

The study confirmed the inconsistency of current assessment processes in the ED setting. Completion rates for the four assessments were variable with only 75% of patients completing the A-Westmead, only 59% of patients completing the Rivermead Post-Concussion Symptom Scale

BIST symptom scale

The findings revealed strong support for use of the BIST total symptom score as a measure of overall symptom burden (e.g., evidence demonstrated excellent internal consistency, a single underlying factor structure and no floor or ceiling effects). There was a strong correlation (0.91) between the BIST total symptom scale score and the Rivermead Post-concussion Symptom Scale total score. The scoring cut-off of the BIST (suggesting risk of prolonged recovery and recommending early referral to a concussion clinic) revealed 100% agreement with identified clinical risk factors. Using our new approach, we identified 26/63 (41.3%) patients who would benefit from referral to a concussion service following discharge from the ED. The findings provide evidence of clinical utility, sound measurement properties within the ED population and decision making support.

BIST-Extended post-traumatic amnesia component

The BIST-Extended PTA component demonstrated good agreement with the A-Westmead PTA assessment. The BIST-Extended picked up two cases that needed to be admitted based on clinical decision making but were not picked up by the A-Westmead. Three cases were additionally identified by the BIST-Extended as safe to discharge in comparison to the A-Westmead (based on final clinical discussion to admit or discharge a patient). There were no participants who initially passed the BIST-Extended who then failed at a later timepoint, providing evidence of the recommendation to consider suitability for discharge after the first passed assessment.

What have we actioned already based on the findings?

Modifications to the BIST-Extended including changes to the scenario and pictures have been made following the findings of the pilot.

Conclusions

The findings provide support for the use of the BIST symptom scale within the ED setting. Further research is needed to implement the BIST-Extended to determine utility in identifying PTA within the ED and inpatient setting for CT negative patients before wider implementation is considered.

Background

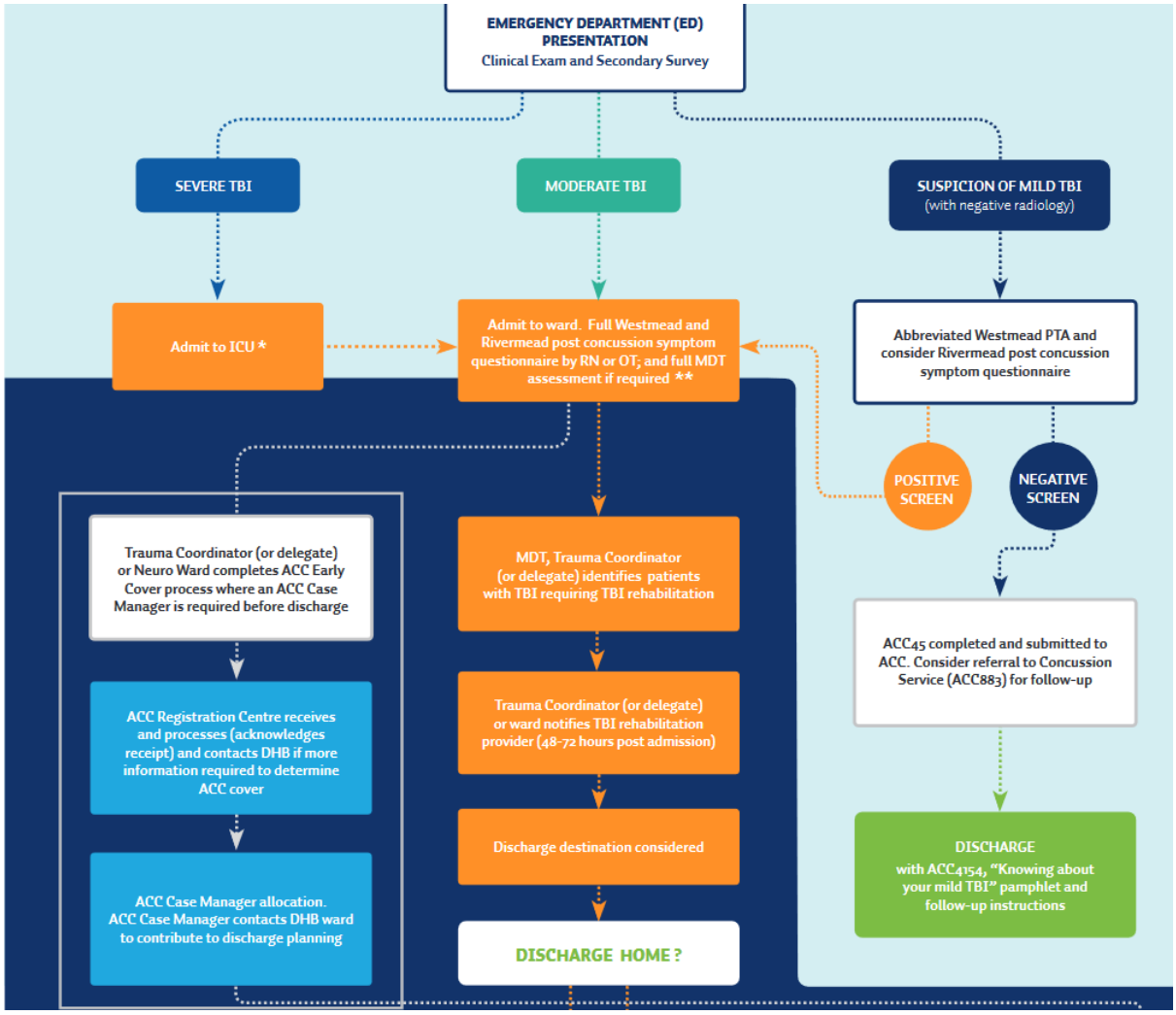
In Aotearoa, New Zealand (NZ) there are 35,000 cases of mild traumatic brain injury (mTBI) every year. Without access to best practice assessment and treatment, nearly half of those affected by mTBI experience persistent symptoms and functioning deficits for months to years following injury.[3-6] Approximately one third of patients present to Emergency Departments (EDs) following a suspected mTBI (ACC unpublished data). Clinical assessment of patients within emergency medicine has a well-defined structured approach. This approach includes the assessment of level of consciousness using the Glasgow Coma Scale (GCS). The findings from the GCS influence the priority and timing of clinical intervention. The Canadian or National Institute for Health and Care Excellence (NICE) guidelines are then used to determine whether the patient should receive a computerized tomography (CT) scan.

If the patient has a positive CT scan (e.g. evidence of blood within the skull or basal skull fracture) the patient is then assessed for post-traumatic amnesia using the [Full] Westmead Post-traumatic amnesia (PTA) scale. The presence of post-traumatic amnesia (PTA) has been found to be a key predictor of long-term outcome following TBI and is an essential component of the assessment to determine if a patient is safe to discharge. If a CT scan is negative, patients currently receive the Abbreviated Westmead PTA scale (A-Westmead). If the patient fails the A-Westmead and continues to exhibit PTA for several hours or is unable to function due to severe symptoms (e.g. unable to ***safely*** mobilise due to symptoms such as severe dizziness) they are admitted to hospital. The A-Westmead is then be completed every hour for four hours or until the person passes the test (out of PTA). If the patient passes the A-Westmead the patient can be considered for discharge home.

Following an assessment of PTA an assessment of symptom severity is then recommended such as the Rivermead Post-concussion symptom scale. An understanding of symptoms can be used to determine the extent of symptoms burden and help with decision making about onward referral following discharge from hospital and tailoring recovery advice to the individual's symptom experience.

In addition to these clinical assessments a range of variables including age, injury mechanism, additional injures or exacerbating comorbid conditions and patient functioning contribute to the risk profile to determine whether the patient is admitted to hospital or discharged home. Figure 1 outlines the current recommended assessment processes.

Figure 1. Current clinical assessment processes for TBI in the hospital setting as outlined in the Major Trauma Network TBI Toolkit



https://www.majortrauma.nz/publications-resources/trauma-resources-and-guidelines/traumatic-brain-injury-toolkit/

Despite these outlined processes, consultation with ED staff in different DHBs suggests that current processes are not being consistently implemented in hospitals across NZ, particularly with regards to mTBIs. The recognition and assessment of mTBIs across NZ remains highly variable, leading to inequity of care. One in five mTBI cases (23%) are missed (not coded) due to focussing on more acute or life-threatening injuries and the absence of a consistently screening approach. Without a mTBI diagnostic code it is extremely difficult for patients to access support or specialist concussion services following discharge. Additionally, consultation identified a lack of understanding of mTBI in the ED resulting in missed diagnoses e.g. comments in medical notes have included "no concussion as no loss of consciousness" or "no concussion as no direct hit in the head" both of which do not rule out mTBI.

Early access to specialist care (e.g. multidisciplinary concussion services) for those at risk of prolonged symptoms significantly improves recovery.[7] However, the average time from injury to concussion services in NZ is currently 60 days.[8] Due to these delays in receiving rehabilitation, symptoms can worsen, threatening employment and social relationships.

Consequently, a more intensive (and costly) service is required to manage the injury alongside increasing levels of stress and anxiety for the patient. Indeed, one in four (24%) people who need specialist treatment receive services for >6 months with costs burdened by patients, whānau and society.[8]

There are several identified challenges with some specific assessment tools recommended within the current process. In Counties Manukau DHB, staff report that the A-Westmead assessmentused for mTBI may be confused with the [Full] Westmead assessment tool used for moderate to severe TBI. Use of the incorrect version of the Westmead can disrupt the accuracy of assessment of PTA going forwards. Additionally, only one set of three pictures is available, so if the person has experienced multiple injuries within a short timeframe, this can affect accuracy of the test (as the ability to retain new memory as designed to be assessed by the test is assisted by long term memory of the same pictures).

The Rivermead Post-Concussion Symptom Scale was designed as a research tool to study chronic effects of TBI. It has an unstable multiple factor structure over time and in different populations preventing its use to monitor symptoms for the general population.[2] The language is complicated with a Fleisch Kincaid Readabiliy Grade Score of 9.9 (Extremely difficult to read). Best understood by university graduates). For example, the scale includes terms such as nausea. Difficulty understanding the language can affect patients' ability to accurately report their symptoms. As the symptom scale was designed for research purposes it lacks relevance for the acute setting. For example, some items such as sleep disturbance cannot be reported on the day of injury before the person has not yet experienced a night's' sleep, and this can underestimate overall symptom burden. The scoring options are problematic with 0 = not experienced at all and 1 = no more of a problem (than before the injury) making interpretation of the total score more difficult (e.g. a score of 16 = no symptoms).

There has been no evidence of cultural responsiveness for either the Westmead PTA scale or Rivermead Post-Concussion symptom scale. Current tools do not provide any guidance to the treating clinician on how symptom presentation may influence referral decision making (e.g. who needs a referral to a concussion clinic and who needs a referral to their GP). The need for two tools (PTA and symptom scale) for CT negative patients means there is increased likelihood that only one of the two assessments are completed. Consequently, a single tool that encompasses both PTA and symptom components, and that could support clinical decision making regarding patient pathways, may provide an easier to follow process with additional clinical utility for mTBI.

The need for a best practice, equitable approach to mTBI screening and management in NZ was identified in 2018 by a working group including people with lived experience of mTBI, GPs, trauma specialists, sports physicians, psychologists, rehabilitation providers, ACC, Māori co-investigators and academics.[9] The review of current assessment tools identified there was no tool fit for purpose for use in the acute general population medical context (e.g. primary or hospital care). Following a literature review of risk factors for poor mTBI recovery and international guidelines, the working group developed the Brain Injury Screening Tool (BIST) to meet the identified need for screening and health pathway decision making.[9]

A series of collaborative projects were undertaken to determine clinician, patient and whānau acceptability, cultural responsiveness, reading age (6-8 years), factor structure, internal consistency, test-retest reliability and concurrent validity of the BIST with existing tools including the Sport Concussion Assessment Tool (SCAT-5) and the Rivermead Post-Concussion Symptom Scale.[9, 10]

Parallel studies are underway to test the feasibility and clinical utility of the BIST within primary care and prison health settings. To enable utility in the ED setting, an additional component was added to the BIST (resulting in the BIST-Extended tool) which assesses PTA whilst retaining the health care pathway decision making guidance based on evidence-based indicators of poor recovery.

Aim

This study aimed to test the feasibility and clinical utility of the BIST symptom scale and BIST-Extended PTA scale within the ED at Middlemore Hospital (Counties-Manukau DHB).

Specific objectives were to:

1) Determine feasibility of implementing the BIST symptom scale and BIST-Extended PTA component within the ED setting
2) Determine concurrent validity of the BIST-Extended (PTA scale) with the Abbreviated Westmead (comparison in the number of people who pass/fail)
3) Determine concurrent validity of the BIST symptom scale with the Rivermead Post-concussion Symptom Scale (correlation between symptom burden scores) within an ED population.
4) Determine the factor structure and internal consistency of the BIST symptom scale in an ED population.
5) Determine the proportion of people meeting suggested referral criteria to concussion services embedded within the BIST following discharge from hospital with diagnosed mTBI.

Methods

Adults and Children (over 8 years of age) who presented to the ED in Counties-Manukau DHB between 27/12/2022 and 22/02/2022 with a suspected mild TBI were eligible to take part in the feasibility study. The recruitment period was initially planned to extend until recruitment reached N=100, however, the pilot was stopped early due to the ED becoming extremely busy due to the COVID-19 pandemic. Sample size recommendations for factor analysis require a minimum of five times the number of variables (so for the 12-item BIST a minimum of n=60 were required) so a sufficient sample size had been achieved to meet the aims of the study.

Ethics approval was obtained from the Health and Disability Ethics Committee (HDEC Ref: 20/CEN.201) and Counties-Manukau DHB Ethics Committee.

A Registered Nurse employed by Auckland University of Technology (AUT) to conduct the BIST-Extended approach alongside current clinical assessments as administered by the DHB ED team. The researcher was present in the ED across different days (weekdays and weekends) and across different shifts (morning, afternoon and evening) to increase representativeness of the study sample. The researcher checked ED patient lists at the start of each shift to determine whether patients met the inclusion criteria to take part.

Exclusion criteria: Patients who had a pre-injury cognitive disorder (e.g. dementia), who required surgery, had experienced a moderate to severe TBI or had a positive CT scan, were inaccessible due to alcohol or pharmacological (recreational or therapeutic) intoxication or who had been abusive to ED staff, were excluded and not approached by the researcher. Patients awaiting their CT scan results were not approached until their results were returned. Those who were discharged home before a researcher was available were not invited to

participate. Where there was uncertainty as to eligibility, the researcher checked with staff on duty.

Inclusion criteria: All trauma patients aged >8 years of age, able to provide informed consent (or provide assent alongside parental consent if between 8 and 16 years).

Patients who met the inclusion criteria, were approached by the researcher who informed them about the study, provided them with a participant information sheet outlining what would be required and the potential risks and benefits. If patients were interested in taking part in the study formal consent was obtained by the researcher with entry in the clinical notes confirming enrolment in the study.

Assessment Measures

Abbreviated Westmead (A-Westmead)

The A-Westmead assessment was derived from the Westmead Post-Traumatic Amnesia Assessment for use in mTBI. The assessment determines a patient's orientation by asking questions including, what is your name? What is the name of this place? Why are you here? What month are we in? What year are we in? The patient is then shown three pictures for five seconds and asked to say what the pictures are (to ensure recognition). The patient is then instructed to remember the three pictures as they will asked to recall them in one hour. In one hours' time the patients is then asked "What were the three pictures that I showed you earlier?" Patients who are able to recall all 3 pictures correctly and answer the five orientation questions correctly are deemed to have passed the assessment (not in PTA). For patients who are unable to recall the pictures, or only recall 1 or 2 pictures correctly are then presented with a series of 9 pictures to act as a prompt. If they are able to correctly recall the three pictures, then are also deemed to not be in PTA. If they are not able to recall the pictures despite the prompt pictures the patients is considered to have failed the assessment and are considered in PTA. The three pictures the patient needs to remember are presented again and the process in repeated every hour for four hours or until they pass the assessment.

Rivermead Post-concussion symptom scale

The Rivermead Post Concussion symptom scale (RPQ) is a scale that assesses the frequency and severity of 16 symptoms commonly experienced after a mTBI including headaches, noise sensitivity, fatigue and sleep disturbance. Patients are asked to rate how much they experience each symptom now in comparison to before their injury on a scale of 0 (not experienced) to 4 (severe). A total score can be calculated as a measure of overall symptom severity (0-64).

Brain Injury Screening Tool (BIST/BIST Extended)

The Brain injury Screening Tool (BIST)[9] consists of a number of questions that asks for details about the incident to ascertain if there are any risk factors for a prolonged recovery e.g. history of mTBI or prolonged recovery from mTBI identified from the research evidence. As many injuries present to the ED on the day of injury, the 12-item symptom scale was used for this study (this is because patients are not able to comment on symptoms such as poor sleep on the day of injury). Patients are asked to rate how much they are experiencing each of the 16 symptoms on a scale of 0-10. The BIST 12 item scale has three underlying clusters (factors) including physical symptoms (headache), vestibular-ocular symptoms (such as dizziness) and cognitive symptoms (such as difficulty remember things).

The extended component of the BIST was developed specifically for the ED setting. This includes a brief assessment of PTA. There are three different scenarios able to be presented to the patient (e.g., to enable use of a different scenario if the patient has recently been seen in the ED for another injury). Only one scenario of the three is selected. The patient is shown three pictures of the items and asked to say what they are to support recall and confirm correct recognition. The scenario is then presented to the patient (e.g., I need to the supermarket and buy eggs, ice cream and a hairbrush and they are asked to remember three items). The scenarios were developed using items identified as being culturally neutral to enable recognition across a range of cultures and included situations recognisable across age ranges. One hour later the patient is asked to remember the three items. If all three items are recalled correctly the patient is deemed to not be in PTA and can be considered for discharge. If one or more items are not recalled correctly, they are shown the three pictures again and the scenario is repeated one hour later. The test is repeated every hour for four hours or until the patient passes the assessment (and deemed out of PTA).

Results

There were 118 participants who were eligible to take part in the study during the two-month recruitment period.

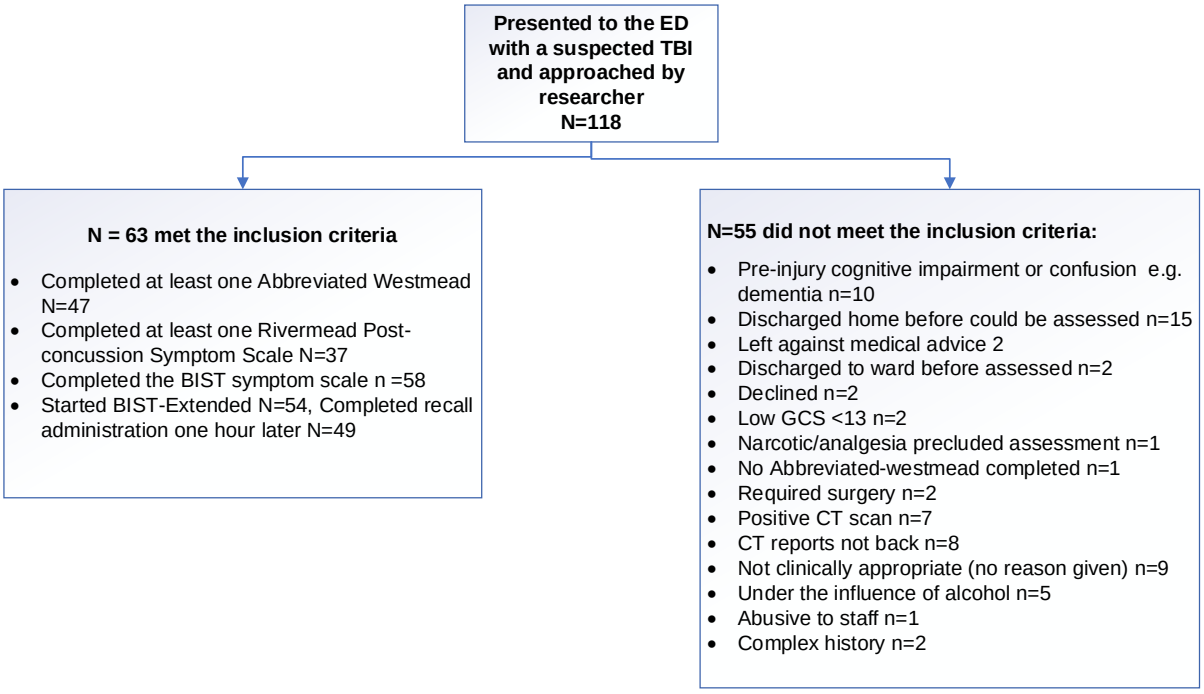


Figure 2. Flowchart of participants enrolled into the study

Reasons for non-eligibility for the study (Figure 2) included participants not meeting the criteria for mild TBI and had a low GCS score or required surgery. Delays in being able to approach patients were experienced such as the need to await for CT scan results or for the A- Westmead to be completed. This affected the number of participants who could be approached for the study. Additionally a number of participants had already been discharged home before being able to be contacted by a researcher reduced the number of participants able to be assessed in the recruitment period.

The sample reflected the characteristics of a mTBI population well including participants aged between 9 and 91 years (Mean age 46 years, SD 24.6), with a higher proportion of males. One third of the sample identified as being of Māori or Pasifika ethnicity. The majority of injuries were caused by a fall and occurred across a range of contexts including activities or daily living, sports and whilst travelling. One in five patients reported experiencing a loss of consciousness, with one third reporting experiencing a TBI prior to the current injury. Patients presented to the ED on average 2.4 days post-injury (Median 16 hours), ranging between 2.1 hours and 21.8 days post-injury.

Table 1. Sample characteristics of the 63 patients assessed for mTBI

		Frequency (%)
Sex	Male	38 (60.3%)
	Female	24 (38.1%)
	Not stated	1 (1.6%)
Ethnicity most identify with	European	26 (41.3%)
	Māori	16 (25.4%)
	Pasifika	8 (12.7%)
	Asian	8 (12.7%)
	Middle Eastern	2 (3.2%)
	Other	2 (3.2%)
	Not stated	1 (1.6%)
Mechanism of injury	Assault	10 (15.9)
	Hit by object or hit head against object	12 (19.0)
	Vehicle accident	11 (17.5)
	Fall	28 (44.4)
	Patient has no recall of what happened	1 (1.6)
	Not stated	1 (1.6)
Worst GCS	14	2 (3.2)
	15	60 (95.2)
	Not stated	1 (1.6)
Time since injury to medical assessment	Within 24 hours of injury	35 (64.1)
	Between 1 and 3 days post-injury	14 (22.2)
	Four or more days post-injury	11 (17.4)
	Not stated	3 (<1.0)
Loss of consciousness	None	49 (77.8)
	Brief ≤1 minute	7 (11.1)
	2-10 minutes	4 (6.3)
	≥ 10 minutes	2 (3.2)
	Unknown	1 (1.6)
Prior TBI History	None	39 (61.9)
	1	7 (11.1)
	2-10	9 (14.3)
	10 or more	3 (4.8)
	Unsure how many	3 (4.8)
	Not stated	2 (3.2)

Rates of application of current processes

Not all patients in the study received current recommended assessment processes. For example, only 74.6% of patients received an A-Westmead PTA assessment and 58.7% received the Rivermead Post-concussion symptom scale. These results provide further evidence that current processes are not being applied consistently to every patient who presents to the ED following trauma.

As the study protocol entailed waiting until the A-Westmead assessment was conducted first (standard clinical practice), a number of participants had already been admitted to hospital or discharged home before the BIST-Extended could be completed.

All pictures of the BIST-Extended presented to 54 participants were recognised and repeated correctly on first presentation (time 1). Tweaks to some pictures were identified by participants. For example, the picture of shoes was changed from dress shoes to sports shoes and separate candles were used instead of candles in a candelabra to reflect the scenarios presented to patients more accurately.

There were 43 participants who completed at least one recall assessment (time 2, one hour after picture presentation) for the A-Westmead and BIST-Extended

No participants who passed the BIST-Extended on first recall (time 2) failed at a later time point. This confirms that consideration for discharge can be made after first correct recall assessment.

Table 2. Outcome results of the completed PTA assessments for all patients in the study

Assessment, time (number of patients)	Pass: number of patients (%)	Fail: number of patients (%)
Abbreviated Westmead		
Time 1 recognise and repeat	-	-
Time 2 recall (47)	40 (85.1)	7 (14.9)
Time 3 recall (5)	2 (40)	3 still in PTA (60)
Time 4 recall (1)	1 (100)	0 (0)
BIST-Extended		
Time 1 recognise and repeat	-	-
Time 2 recall (49)	42 (85.7)	7 (14.3)
Time 3 recall (39)	38 (97.4)	1 still in PTA (2.6)
Time 4 recall (4)	3 (75.0)	1 still in pTA (25.0)

Both the BIST-Extended and A-Westmead were completed for 43 patients at the first recall assessment (time 2). For these 43 patients 32 (74.4%) passed both tests and three (7.0%) failed both tests. These findings indicate 81.3% level of agreement between the A-Westmead and the BIST-Extended.

For the eight participants (18.6%) where there was disagreement between the BIST-Extended and the Abbreviated Westmead;

- Four participants passed the BIST-Extended but failed the A-Westmead. Of these four, three were safely discharged home by the clinician, one was admitted to hospital but clinical decision was this case was not a TBI).
- Four participants passed the A-Westmead but failed the BIST-Extended. Of these four, two were admitted to hospital based on clinical decision (both had high

symptom profiles and a meaningful concussion history), the other two were 79 and 84 years old presenting on the day of injury. Both passed the BIST-Extended PTA assessment one hour later and were discharged home. These two failures of the BIST-Extended are likely to be due to the study design where participants needed to remember two sets of pictures as assessments were done concurrently making it harder for them to remember (only one item was incorrectly recalled on the BIST-Extended that they did not pass). This also supports the need for testing patients who fail the test at subsequent hourly intervals so that if patients fail the assessment there is a further opportunity to pass if they failed for a reason other than PTA or as soon as PTA is resolved to prevent unnecessary admission to hospital.

Performance of BIST symptom scale Performance in the ED Setting

There were 63 participants who completed the BIST symptom scale (12 items to include those presenting on day of injury). The BIST symptom total score was found to be highly correlated with the Rivermead Post-concussion scale total score with a Spearman's correlation co-efficient of r=0.91, providing support of concurrent validity of the BIST symptom scale in the ED population.

Total scores on the 12-item BIST symptom scale extended across the whole range of possible scores between 0–120, suggesting no floor or ceiling effects were observed. The average symptom burden score was 22.2 (SD 29.9), with a median score of 11.0 (interquartile range of 22.0).

Factor structure and internal consistency of the BIST symptom scale in an ED population

Principal components analysis was conducted to determine how the symptom items are related to each other. The data were found to be suitable for factor analysis with a Kaiser-Meyer-Olkin measure of sampling adequacy of 0.88. One single factor solution was identified (each item loading onto the same factor with a eigenvalue of ≥0.4 see Table 3.) This provides support for the performance of the BIST-12 total symptom score to measure overall symptom burden in the acute ED setting. Additionally, the Cronbach's alpha for the 12-item BIST symptom scale was 0.95, indicating excellent scale reliability. This suggests that the 12-items of the BIST are closely related and are measuring the same construct and support use of a total symptom severity score. This study provides support for use of the BIST symptom scale in the ED.

Table 3. Item factor loadings onto the one underlying component of the BIST-12 symptom scale.

BIST-12 Item	Loading
Headache (my head hurts)	.738
My neck hurts	.540
I dont like bright lights	.766
I dont like loud noises	.816
I feel dizzy or like I could be sick	.821
If I close my eyes, I feel like I am at sea	.878
I have trouble with my eyesight (vision)	.857
I feel clumsy	.755
It takes me longer to think	.863
I forget things	.879
I get confused easily	.940
I have trouble concentrating	.857

Proportion of people meeting suggested referral criteria to concussion services based on clinical indicators and BIST symptom severity score

Recommended criteria for direct referral to a concussion clinic based on the BIST include history of previous TBI or prolonged recovery from mTBI, high acute symptom severity (BIST symptom total severity score of ≥50 on the 12-item scale), high vestibular-ocular symptoms, high risk injury (e.g., high speed (>50 kmh) or fall from height), likelihood of psychological trauma following the incident (e.g fatal vehicle accident, assault) and history of mental health difficulties. These factors were identified following a review of the evidence of factors found to be consistently predictive of poor recovery from mTBI.
Each patient's case was reviewed for whether they would meet recommended criteria for referral to a concussion service following discharge from the ED. There were 26/63 (41.3%) who met the criteria for consideration for referral to concussion service. All those who met criteria for referral to concussion service based on the BIST symptom score cut off **also** had at least one additional clinical concern (e.g. high risk accident or previous history of prolonged recovery from mTBI).

Research Team

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