Clinical Gestalt for Early Prediction of Delayed Functional and Symptomatic Recovery From Mild Traumatic Brain Injury Is Inadequate

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There are limited prognostic tools to guide clinicians in acute risk stratification of adult mild traumatic brain injury patients (mTBI). While the majority of mTBI patients achieve full recovery within 7 to 14 days, approximately 25% to 30% remain symptomatic for 3 or more months postinjury.[1,2] Early identification of the subset of mTBI patients at high risk for protracted recovery will: 1) facilitate administering the right discharge instructions and subspecialty referral to the right at-risk mTBI patients; 2) enable individualized education of patients regarding their expected course of recovery; 3) allow targeted administration of cognitive and behavioral therapy that has been found to be efficacious when implemented during the acute phase of injury;[3–5] and 4) enable enrichment of study populations of mTBI clinical trials with patients who are at risk for protracted recovery and therefore decrease the sample size required for demonstrating therapeutic efficacy.[6]

We performed a substudy of participants who were enrolled in the Head Injury Serum Markers for Assessing Response to Trauma (HeadSMART) study, an observational prospective cohort study. HeadSMART study design and methods have been previously published.[7] Briefly, we included ED patients 18 years or older, who presented to an urban academic medical center within 24 hours of injury, met the American College of Emergency Physicians' criteria for evaluation of TBI with a head CT scan, received head CT imaging, and provided written informed consent. The study was approved by the local institutional review board.

Demographic and injury characteristics were based on participants' self-report obtained by trained research coordinators and a review of the electronic medical record. The resident physician or midlevel provider responsible for the clinical care of an enrolled participant was interviewed regarding the participant's prognosis. The treating attending physician was also interviewed independently. Interviews occurred after results of diagnostic tests were available. The text of the prognosis questions asked is presented

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Follow-up was conducted either via telephone or an in-person assessment at 1, 3 and 6 months postinjury. Functional recovery was ascertained using the Glasgow Outcome Scale Extended (GOSE) and symptomatic recovery was ascertained using the Rivermead Post-Concussion Questionnaire (RPQ). Delayed functional recovery was defined as GOSE score < 8 at 3 months postinjury. Delayed symptom recovery was defined as having three or more postconcussive symptoms (PCS) at 3 months postinjury that were graded as mild or more severe problems compared to their preinjury status. Outcome assessments were performed by trained research coordinators and reviewed by a board-certified neuropsychologist for accuracy.

Head CT scans were reread by one board-certified neuroradiologist and classified as having either a traumatic intracranial abnormality/skull fracture or not. The professional experience of clinicians was quantified based on the number of years since graduating from professional school into: 0 to 1, 1 to 2, 3 to 4, and more than 4 years for resident physicians and midlevel providers and 0 to 9, 10 to 19, and 20 years or more for attending physicians. Clinicians were asked to rate the certainty of their prediction on a scale of 0% to 100%. These ratings were then categorized into three groups: low (0%–49%), moderate (50%–89%), and high (90% or greater).

The accuracy of clinician gestalt was determined by comparing clinical prediction to participant outcome. The discriminative ability of clinical gestalt was quantified with the area under the receiver operator curve (AUC). We tested for differences in the predictive accuracy of clinical gestalt according to professional experience and certainty of prediction, using the chi-square test. Accuracy was defined as the number of correct predictions (true positives + true negatives) divided by the total number of predictions. A two-tailed p-value of <0.05 was considered statistically significant.

A total of 217 subjects met the inclusion criteria for this analysis. Included subjects were predominantly male (59.6%), and Caucasian (50.7%) and had a median age of 43 years. The most common mechanism of injury was falls (31.8%). At presentation, 192 (88.5%), 23 (10.6%), and two (0.9%) subjects had a Glasgow Coma Scale of 15, 14, and 13, respectively. Traumatic intracranial injuries were identified on the head CTs of 32 (17.1%) subjects. The distribution of GOSE scores at 3 months were as follows: among the 217 subjects studied, 115 (53.0%) had delayed functional recovery and 105 (49.3%) had delayed symptom recovery. At 3 months, five, one, three, 17, 33, 56, and 102 subjects had GOSE scores of 1 to 8, respectively. A total of 80 residents and midlevel providers were interviewed at least once. Among these clinicians, 23 (28.8%), 27 (33.8%), 28 (35.0%), 13 (16.2%), and 19 (23.8%) had 0 to 1, 1 to 2, 3 to 4, and >4 years of professional experience, respectively. A total of 32 attending physicians were interviewed at least once. Among attending physicians, 13 (40.6%), 13 (40.6%), and six (18.8%) had 0 to 9, 10 to 19, and 20 years or greater of professional experience.

Resident physicians and midlevel providers predicted that nine (4.2%) subjects will have delayed functional recovery at 3 months postinjury (Table 1), yielding an accuracy of 48.4% (95% confidence interval [CI] = 41.7% to 55.1%) and an AUC of 0.51 (95% CI = 0.48 to 0.54). Among resident/midlevel providers, three (1.4%), 67 (31.0%), and 146 (67.6%) had low, moderate, and high certainty of the accuracy of their prediction of functional recovery, respectively. The accuracy of predicted functional recovery was 33.3, 31.3, and 56.8% (p = 0.003) among those with low, moderate, and high certainty, respectively.

Residents and midlevel providers predicted that 55 (25.3%) participants will have persistent PCS at 3 months postinjury, yielding an accuracy of 59.6% (95% CI = 53.0% to 66.3%) and an AUC of 0.60 (95% CI = 0.54 to 0.65). Among resident/midlevel providers, nine (4.2%), 100 (46.3%), and 107 (49.5%) had low, moderate, and high certainty of the accuracy

Table 1
Diagnostic Accuracy of Clinical Gestalt for Predicting Functional and Symptom Recovery

Resident/midlevel	Delayed Functional Recovery (%)	Delayed Symptom Recovery (%)
Sensitivity	5.2	34.3
Specificity	97.1	84.3
Positive predictive value	66.7	67.9
Negative predictive value	52.4	43.1
Attending		
Sensitivity	8.1	54.5
Specificity	92.5	82.5
Positive predictive value	50.0	63.2
Negative predictive value	52.1	60.0

of their prediction of symptom recovery, respectively. The accuracy of predicted symptom recovery was 44.4, 58.3, and 62.0% (p = 0.52) among those with low, moderate, and high certainty, respectively.

Attending physicians provided their clinical gestalt in 77 (36.5%) cases. Attending physicians predicted that six (7.8%) of participants will have complete functional recovery at 3 months postinjury, yielding an accuracy of 51.9% (95% CI = 40.5% to 63.4%) and an AUC of 0.50 (95% CI = 0.44 to 0.56). Among attending physicians, 0 (0%), 24 (31.6%), and 52 (68.4%) had low, moderate, and high certainty of the accuracy of their prediction of functional recovery, respectively. The accuracy of predicted functional recovery was 33.3 and 59.6% (p = 0.03) among those with moderate and high certainty, respectively.

Attending physicians also predicted that 19 (25.0%) of participants will have persistent PCS at 3 months postinjury, yielding an accuracy of 60.8% (95% CI = 49.4% to 72.2%) and an AUC of 0.59 (95% CI = 0.49 to 0.69). Among attending physicians, four (5.6%), 33 (43.4%), and 39 (51.3%) had low, moderate, and high certainty of the accuracy of their prediction of symptom recovery, respectively. The accuracy of predicted symptom recovery was 50, 53.1, and 68.4% (p = 0.38) among those with low, moderate, and high certainty, respectively. The accuracy of clinical gestalt did not vary according to the number of year of clinical experience.

To our knowledge this is the first study of the accuracy of emergency physicians' clinical gestalt for predicting mTBI outcome in adult participants on the day of injury. We report four major findings. First, clinicians studied had an optimistic view regarding the prognosis of mTBI, despite the fact that the study cohort consisted of significantly injured subjects (17% positive CT and a high rate of delayed recovery). They expected more than 90% of subjects to have complete functional recovery whereas in reality, approximately 50% of the cohort studied had delayed functional recovery and persistent PCS. Second, ED resident/midlevel provider accuracy for predicting functional recovery and persistent PCS are low (48.2 and 59.8%, respectively). The accuracy of resident/midlevel providers' gestalt was low even among residents/midlevel providers who were more than 90% certain of the accuracy of their prediction. However, there was a trend toward higher accuracy with higher degree of certainty of prediction. Third, the accuracy of attending clinician gestalt for functional recovery and PCS is also low (51.9 and 60.8%, respectively). Similar to residents/midlevel providers, there was a trend toward higher accuracy with higher degree of certainty of prediction. Fourth, clinician experience did not influence the accuracy of predicting mTBI outcome.

Despite its strengths, our study also has a number of limitations. First, the observed prevalence of poor outcomes following mTBI in our cohort was higher than the prevalence reported in other mTBI studies (approximately 50%[1,2,8] vs. 30%), but similar to a recently published large observational study.[9] Thus our population may be more severely injured than others. However, this should not affect the sensitivity or specificity of clinical gestalt. Second, our study was performed at two hospitals that are part of one health system, and therefore it is possible that findings may not be generalizable. A prior multicenter study reported similar findings in a pediatric population.[10] Third, although the RPQ is one of the most commonly used tools for ascertaining mTBI outcomes, it is limited in its ability to distinguish between concussion- and non–concussion-related symptoms.

The accuracy of clinical gestalt for predicting mTBI outcomes on the day of injury is poor. Data-driven strategies are needed to provide clinical decision support for mTBI risk stratification in acute care settings.

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Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13844/full

Data Supplement S1. Interview Questions for Clinicians.