Benefits of Strict Rest After Acute Concussion: A Randomized Controlled Trial

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OBJECTIVES: To determine if recommending strict rest improved concussion recovery and outcome after discharge from the pediatric emergency department (ED).

METHODS: Patients aged 11 to 22 years presenting to a pediatric ED within 24 hours of concussion were recruited. Participants underwent neurocognitive, balance, and symptom assessment in the ED and were randomized to strict rest for 5 days versus usual care (1–2 days rest, followed by stepwise return to activity). Patients completed a diary used to record physical and mental activity level, calculate energy exertion, and record daily postconcussive symptoms. Neurocognitive and balance assessments were performed at 3 and 10 days postinjury. Sample size calculations were powered to detect clinically meaningful differences in postconcussive symptom, neurocognitive, and balance scores between treatment groups. Linear mixed modeling was used to detect contributions of group assignment to individual recovery trajectory.

RESULTS: Ninety-nine patients were enrolled; 88 completed all study procedures (45 intervention, 43 control). Postdischarge, both groups reported a 20% decrease in energy exertion and physical activity levels. As expected, the intervention group reported less school and after-school attendance for days 2 to 5 postconcussion (3.8 vs 6.7 hours total, \(P < .05\)). There was no clinically significant difference in neurocognitive or balance outcomes. However, the intervention group reported more daily postconcussive symptoms (total symptom score over 10 days, 187.9 vs 131.9, \(P < .03\)) and slower symptom resolution.

CONCLUSIONS: Recommending strict rest for adolescents immediately after concussion offered no added benefit over the usual care. Adolescents’ symptom reporting was influenced by recommending strict rest.

WHAT’S KNOWN ON THIS SUBJECT: Expert consensus recommends rest after concussion with stepwise return to activity. Animal and retrospective human data suggest that early mental and physical activity may worsen outcome. There are no pediatric studies testing the efficacy of recommending strict rest after concussion.

WHAT THIS STUDY ADDS: Recommending strict rest postinjury did not improve outcome and may have contributed to increased symptom reporting. Usual care (rest for 1–2 days with stepwise return to activity) is currently the best discharge strategy for pediatric mild traumatic brain injury/concussion.
Pediatric head trauma represents a significant injury burden for children, and emergency department (ED) visits for sports-related traumatic brain injury (TBI) have increased 60% over the previous 10 years.1 Most of these patients are discharged from the ED with a diagnosis of concussion and are instructed to rest. Rest recommendations are motivated by a concern for reinjury during recovery from a concussion.2,3 Additionally, retrospective studies and animal models demonstrate that early physical and mental activity can impair recovery.4–7 Because human data on postinjury exertion is limited, expert consensus recommends 24 to 48 hours of rest before beginning a stepwise return to activity.8 Many clinicians recommend a longer period of rest, and some clinicians have advocated “cocoon therapy,” which restricts patients to several days in a darkened room before slowly returning to activity.9 To date, the optimal period of rest after concussion remains unknown.

We sought to investigate the effectiveness of recommending 5 days of strict rest compared with the usual care of 24 to 48 hours of rest on outcomes after discharge from the ED with acute concussion. We hypothesized that patients who were recommended strict rest after injury would have a greater decrease in physical and mental activity and improved mean neurocognitive, balance, and symptom outcomes compared with patients who were recommended the usual care.

### METHODS

#### Design and Procedures

The study was a prospective randomized controlled trial of patients presenting to the Children’s Hospital of Wisconsin Emergency Department and Trauma Center with mild TBI/concussion (mTBI) between May 2010 and December 2012 (see study overview, Fig 1). mTBI was defined by using the Acute Concussion Evaluation (ACE) form, a standardized tool endorsed by the Centers for Disease Control (CDC). The study was approved by the Children’s Hospital of Wisconsin Institutional Review Board and registered with ClinicalTrials.gov (NCT01101724).

#### Study Participants

Patients were screened for eligibility if they presented with a chief complaint of an injury to the head (eg, head injury, scalp laceration), including any associated mechanism with the potential to have sustained direct force or transmitted force to the head (eg, motor vehicle collision, fall). Children were eligible if they were 11 to 22 years of age and presented to the ED within 24 hours of injury and were diagnosed with a concussion. Patients were excluded if they were non-English speaking or if their guardian could not consent in English, were diagnosed with intellectual disability (IQ <70) or a previous mental defect or disease (eg, attention-deficit/hyperactivity disorder or learning disability), were diagnosed with an intracranial injury (eg, intracranial bleeding, cerebral contusion), had no legal guardian present, were being admitted, or had conditions that interfered with valid assessment of signs and symptoms, neurocognitive, or balance testing. In addition, patients were excluded if their clinician was uncomfortable with study procedures (eg, randomization or time needed for ED assessments) or if the patient lived >1 hour from the Medical College of Wisconsin. Imaging, not necessary for study participation, was obtained at the discretion of the treating clinician. Assent was obtained from patients, and informed consent was obtained from caregivers.

#### Procedures

Adolescents underwent initial screening to gather demographic information, injury details, initial symptoms, and risk factors for prolonged recovery (eg, history of previous concussion or migraine). Patients also received computerized neurocognitive testing and a standardized balance assessment in private rooms in the ED. Attempts were made to minimize distractions and interruptions during testing (eg, turning off the TV, sending younger siblings to the waiting room, placing a sign on the door notifying staff that testing was in progress). Participants were then randomized to 1 of 2 groups using randomization in blocks of 4 with sealed envelopes (a random number generator to assign groups). Participants, parents, and health care providers were notified immediately of the results of the randomization.

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**FIGURE 1**

Study overview.
A trained research assistant arranged follow-up appointments with the participants for 3 and 10 days after their ED visit, at which time repeat neurocognitive tests and balance assessments were administered. For the majority of patients, follow-up measures were administered by a research assistant in the patient’s home in a quiet environment. A small number of patients returned to the hospital for testing in our Translational Research Unit, a corporate office suite, or an ED room. The principal investigator (DT) and coinvestigator (JA) reviewed follow-up test results within 48 hours of completion and consulted with the family by phone within 24 to 48 hours to communicate any concerning test results or symptom scores. They remained available for questions throughout the study period. If clinically indicated, patients were referred to the ED, their primary care physician, or a concussion specialist for follow-up.

Interventions
Participants were randomized either to the strict rest (intervention) group or the usual care (control) group. To accurately represent the usual care for mTBI, the treating attending physician was free to verbally recommend activity restrictions as they saw fit in the usual care group. A survey found that a majority of ED physicians at our institution instruct patients to rest for 1 or 2 days and then return to school and a stepwise return to physical activity after the patient’s symptoms have resolved, consistent with best practices outlined by the CDC. The strict rest group received recommendations from the treating physician and discharge instructions to maintain 5 days of strict rest at home (specifically, no school, work, or physical activity) followed by a stepwise return to activity. Because no optimal time of postinjury rest has been determined, this 5-day interval was chosen to maximize differences between usual care and strict rest groups while minimizing the burden placed on the subject and family. The strict rest group was provided school and work excuses for the 5 days postinjury. Both groups received the Ace—Emergency Department (ACE-ED) Care plan, endorsed by the CDC, as discharge instructions and were encouraged to follow up with their primary medical doctor or the Concussion Clinic. Forms differed only in the duration of time for which rest was recommended. Research assistants observed and documented the discharge instruction information provided to each patient to ensure clinician compliance with group allocation.

Assessment and Outcome Measures
Outcome measures were selected to measure both compliance with discharge instructions as well as the effect of those instructions on short-term outcomes (first 10 days).

Compliance: Physical and Mental Activity
The Three-Day Activity Diary has been validated as a measure of activity level and energy expenditure compared with accelerometers and doubly labeled water measurements. Participants record activity levels in 15-minute intervals over the first 3 days. Weight and gender were used to calculate basal metabolic rate, and reported activity levels were used to calculate total energy expenditure. While in the ED, participants retrospectively completed the diary for the first 10 days. Weight and gender were used to calculate basal metabolic rate, and reported activity levels were used to calculate total energy expenditure. While in the ED, participants retrospectively completed the diary for the day before and the day of the ED visit under the guidance of a research assistant. Participants were instructed to complete the diary several times a day, report the time in hours spent on specific mental activities, and note any effects on symptoms. Reportable mental activities were taken from the list of activities participants were advised to limit on the ACE-ED Care form (see Table 1).

Efficacy: Symptom Survey
A standard 19-symptom Post-Concussive Symptoms Scale (PCSS) assessing symptoms in 4 domains (physical, cognitive, emotional, and sleep) was included in the diaries. Each symptom was graded by the subject from none (0) to severe (6) and was obtained daily for the first 10 days. Data were analyzed for total PCSS score, total number of individual symptoms reported, and subtotal scores for each PCSS domain.

Efficacy: Neurocognitive Assessment
Our primary neurocognitive assessment was the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) computerized test battery. ImPACT V2.0 (ImPACT Applications, Inc, Pittsburgh, PA) is a widely used commercial computer-based neurocognitive test platform. This measure has been validated for use in the ED setting and reliably detects neurocognitive deficits after concussion. ImPACT administers 6 neuropsychological test modules, the composite scores of which are reported in 5 fields: Verbal Memory,
Visual Memory, Reaction Time, Processing Speed, and Impulse Control.\textsuperscript{19–29} Scores are assessed based on age- and gender-matched percentiles for 11 to 13 years, 14 to 18 years, and 19 years using existing ImPACT normative data. This test was administered in the ED and at both follow-up visits. In addition to ImPACT, during follow-up visits, subjects completed a paper ancillary neuropsychological test battery. The battery comprised tests demonstrated to be sensitive, valid, and reliable in the assessment of mild traumatic brain injury. The battery included Hopkins Verbal Learning Test, Trail Making Test Parts A & B, Symbol Digit Modalities Test, Letter-Number Sequencing from the Wechsler scales, and Controlled Oral Word Association Test (verbal fluency).\textsuperscript{30–34}

\textbf{Efficacy: Balance Assessment}

The Balance Error Scoring System (BESS) objectively assesses balance.\textsuperscript{35,36} The test consists of 3 stance conditions (double leg, single leg, tandem); each stance is performed with eyes closed on both normal firm flooring and a medium-density foam surface. Inability to maintain stance or eye opening is deemed an error and is recorded as a quantitative measurement of postural instability. Performance is scored by adding the error points for each of 6 trials. BESS was performed in the ED and at 3 and 10 days.

Because of time constraints, patients

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{ ConsortDiagram.png}
\caption{CONSORT (Consolidated Standards of Reporting Trials) diagram. ADHD, attention-deficit/hyperactivity disorder; F/U, follow-up; ICI, intracranial injury. *Did not meet inclusion criteria because they were not diagnosed with concussion.}
\end{figure}

\begin{table}[h]
\centering
\caption{Physical and Mental Activity Diary Metrics}
\begin{tabular}{|p{4cm}|p{1cm}|p{0.7cm}|p{0.7cm}|}
\hline
\textbf{PAR} & \textbf{Intervals Recorded} & \textbf{1–3 d} & \textbf{4–10 d} \\
\hline
A: Sleeping (resting in bed) & 0.95 & 15 min/d & h/d \\
B: Sitting (eating, writing, using the computer, etc) & 1.5 & 15 min/d & h/d \\
C: Standing (washing, combing, shaving, cooking, etc) & 2 & 15 min/d & h/d \\
D: Walking indoors (light home activities) & 2.8 & 15 min/d & h/d \\
E: Walking outdoors (light manual work) & 3.3 & 15 min/d & h/d \\
F: Low intensity Activity (golf, gardening, biking [<6 mph], table tennis, etc) & 4.4 & 15 min/d & h/d \\
G: Moderate-intensity activity (jogging, biking 7–12 mph, hiking, horseback riding, dancing, snow shoveling, loading and unloading goods, etc) & 6.5 & 15 min/d & h/d \\
H: High-intensity activity (running [<6 mph], bicycling (>12 mph), swimming, tennis, basketball, football, soccer, wt training, carrying heavy load upstairs, etc) & 10.0 & 15 min/d & h/d \\
I: Maximum-intensity activity (very high to maximal intensity: competitive running (>6 mph), cross-country skiing, etc) & 15.0 & 15 min/d & h/d \\
\hline
\textbf{Mental activity} &  &  &  \\
(Low) Listening to music/radio or reading & n/a & h/d & h/d \\
(Low) Watching TV, surfing the internet, or playing video games & n/a & h/d & h/d \\
(Moderate) In the classroom during school & n/a & h/d & h/d \\
(Moderate) After-school activities, clubs or job & n/a & h/d & h/d \\
(High) Working on homework or studying & n/a & h/d & h/d \\
(High) Taking quizzes, tests, and or giving presentations & n/a & h/d & h/d \\
\hline
\end{tabular}
\end{table}

Calculations were as follows. Basal Metabolic Rate (BMR) calculated by using Schofield equation: Male, BMR = 0.074 × wt (kg) + 2.754 MJ/d; female, BMR = 0.056 × wt (kg) + 2.898 MJ/d.

Total energy expenditure (TEE) calculated by summing the number of 15-min periods for each categorical value (A–I). Each result was then multiplied by its respective PAR and the subjects predicted BMR. All were then added to determine 24-h exertion. Activity-related energy expenditure calculated by subtracting BMR from TEE. Physical activity level (PAL) calculated by dividing TEE by BMR. PAR, physical activity ratio.
in the ED were only tested on firm flooring and scores assessed for only 3 trials.

Statistical Analysis
To investigate whether treatment led to improved symptom, neurocognitive, and balance outcomes and whether there was a significant difference in recovery trajectory based on treatment group assignment, linear mixed-model analyses were used. Linear mixed modeling demonstrates a mean group effect as well as random effects and allows each subject to have a different recovery trajectory. It also accounts for correlations over time induced by multiple observations on the same subject. If data are not normally distributed, then a general linear mixed model is used. In addition to these analyses, time to symptom resolution (defined as PCSS ≤ 7) was analyzed by using a proportional hazards model. The total number of symptoms reported, neurocognitive and balance outcome differences from ED (day 0) to day 3 and day 10, and differences in activity and symptoms in the first 5 days and over the course of the study were compared by using t tests or Wilcoxon rank sum tests when the data were not normal. Data analysis was conducted by using SAS (V9.3) and Stata (V13.0). The intention-to-treat principle was used for all analyses. Statistical significance was P < .05. The Bonferroni multiple comparisons adjustment for comparison of changes at days 3 and 10 was P < .025. A subgroup analysis was planned a priori to assess how preinjury risk factors and initial presentation influence treatment effects.

Calculation of Sample Size
A priori we determined that a sample size of 44 subjects in each group was sufficient to detect a 12-point difference (a moderate effect size) in total PCSS (based on an estimated SD of 22) for a power of 0.80 and type I error (α) of .05. 28 For the computerized neurocognitive assessment, we were powered to detect minimal clinically significant differences (a difference of 9% in Verbal Memory, 17% in Visual Memory, 15% in Reaction Time, and 14% in Processing Speed).23

RESULTS
Demographics
Three-hundred and seventy patients with mTBI met inclusion criteria during the study period (see Fig 2); 178 met exclusion criterion, and an additional 93 patients declined to participate, leaving a sample of 99 participants who were randomized. The strict rest group was slightly older (mean 14.7 vs 13.1 years), and this was associated with slight differences in weight and basal metabolic rate (see Table 2). One-third of participants in each group were female. There were no significant differences between treatment groups at time of ED evaluation including mechanism of injury, symptoms at ED presentation, history of migraine, previous mTBI, ED evaluation, and ED treatment. The

<table>
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<th>TABLE 2 Demographic Table</th>
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<td>Demographics</td>
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<td>Age, y, median (IQR)</td>
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<td>Basal metabolic rate, MJ/d, median (IQR)</td>
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<td>PAL, median (IQR)</td>
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<td>Moderate–high mental activity, median (IQR)</td>
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<td>Assault, n (%)</td>
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<td>Other, n (%)</td>
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<td>ED reported signs/symptoms</td>
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<td>Immediate symptoms, n (%)</td>
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<td>Loss of consciousness, n (%)</td>
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<tr>
<td>Anterograde amnesia, n (%)</td>
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<td>Retrograde amnesia, n (%)</td>
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<td>Seizure, n (%)</td>
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<td>ED evaluation</td>
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<td>Head computed tomography obtained, n (%)</td>
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<td>ED treatment</td>
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<tr>
<td>Analgesic, n (%)</td>
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<td>Antiemetic, n (%)</td>
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AEE, activity-related energy expenditure; IQR, interquartile range; MVC, motor vehicle collision; PAL, physical activity level; TEE, total energy expenditure.

a P < .05.

b Symptoms include dazed or stunned, confused about events, answers questions slowly, and repeat questions.
most common mechanism of injury was sports, specifically football. Nearly all participants reported some symptoms in the ED and approximately one-third reported a loss of consciousness. Only one-third of the patients in the usual care group were observed verbally receiving a specific duration to restrict activity. Of those who did receive instructions, the median duration of strict activity restriction was 2 days. In the strict rest group, 94% were observed verbally receiving a specific duration to restrict activity with a median duration of 5 days. Follow-up procedures were completed for 88 participants (43 usual care control [C] vs 45 strict rest intervention [I]).

Compliance: Physical and Mental Activity Level

Both groups exhibited an ~20% decrease in energy expenditure and physical activity level in the first 5 days postinjury. The usual care group reported more total hours in high and moderate mental activity on days 2 to 5 than the strict rest group (8.33 [C] vs 4.86 [I] hours, \(P = .03\)), including more school and after school mental activity (6.66 [C] vs 3.77 [I] hours, \(P = .03\)) (see Fig 3).

Efficacy: Symptom, Neurocognitive, and Balance Outcomes

In both groups, >60% of patients experienced symptom resolution (defined as PCSS ≤7) during the follow-up period (67% [C] vs 63% [I], \(P = .82\)). However, it took 3 days longer for 50% of patients in the strict rest group to report symptom resolution compared with the usual care group (see Time to Symptom Resolution, Fig 4). Moreover, the strict rest group reported greater total PCSS scores over the course of the 10-day follow-up period (187.9 [I] vs 131.9 [C], \(P < .03\)), a higher total number of postconcussive symptoms reported during follow-up period (70.4 [I] vs 50.2 [C], \(P < .03\); data not shown) and higher mean daily PCSS clustered around day 4 (see Fig 5). We found no significant differences between groups in computer-based neurocognitive tests and balance scores at 3 or 10 days (see Table 3). Although most paper neuropsychological assessments did not demonstrate a significant difference, the strict rest group performed better at day 3 (59.9 [C] vs 67.6 [I], \(P < .01\)) and worse at day 10 (71.5[C] vs 67.6[I], \(P = .04\)) than the usual care group on the Symbol Digit Modalities Test.

Factors Associated With Recovery and Outcome

Linear mixed modeling did not find significant treatment effects over time based on group assignment for total PCSS and neurocognitive test measures. However, when PCSS was analyzed by domain, assignment to the strict rest group contributed to higher physical symptom scores on days 2 and 3 and a trajectory of higher emotional symptoms throughout follow-up. Additional factors were found in both groups to be associated with longitudinal outcomes. We found that female patients reported higher PCSS scores and lower energy expenditure. As expected during the follow-up period, total daily energy expenditure, physical activity level, and mental activity level significantly increased over time, and PCSS, visual memory, reaction...
Subgroup Analysis

A subgroup analysis suggests a more nuanced relationship between rest and outcomes. Patients diagnosed with concussion based on postconcussive symptoms alone (e.g., headache, dizziness) reported a higher postconcussive symptom score at day 10 when randomized to strict rest (15.2 [I] vs 7.7 [C], \( P = .04 \)). Patients who presented to the ED with immediate signs of concussion (e.g., loss of consciousness >30 seconds, amnesia, or confusion) trended toward lower postconcussive symptom scores at day 10 when randomized to strict rest (11.0 [I] vs 14.6 [C], \( P = .22 \)). Similarly, patients with a past history of concussion reported greater symptoms at day 10 when randomized to strict rest (15.1 [I] vs 5.6 [C], \( P < .05 \)). However, patients who presented with their first concussion showed no difference in symptoms at day 10 based on group assignment. Additionally, although patients with a history of migraines reported higher symptoms at day 10, no differences could be seen based on group assignment. We were not powered to detect differences between specific mechanisms of injury. However, when comparing sport to nonsport mechanisms, we found no differences in outcomes based on mechanism or treatment group assignment.

DISCUSSION

Recommending strict rest from the ED did not improve symptom, neurocognitive, and balance outcomes in youth diagnosed with concussion. Surprisingly, adolescents who were recommended strict rest after injury reported more symptoms over the course of this study. Although recommending strict rest ultimately did not significantly alter the amount of physical activity between groups, it did change the amount of mental activity (e.g., school attendance).

This is the first randomized controlled trial of rest strategies in pediatric patients after acute concussion. Although poor compliance with strict physical rest may have contributed to a lack of efficacy, previous adult studies that have assessed strict rest after concussion found similar results. Relander et al (1972) randomized admitted adult patients with mTBI to bedrest or active therapy and found that subjects in the active group were able to return to work 14 days earlier than the bedrest group. de Kruijk et al (2002) randomized adults discharged with acute mTBI to usual care or strict bedrest and found that both treatments resulted in no significant differences in actual amounts of outpatient bedrest and no differences in outcomes at 2 weeks, 3 months, and 6 months. Given that these previous studies of more stringent rest in concussed adults similarly failed to demonstrate...
TABLE 3 Neurocognitive and Balance Assessments

<table>
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<tr>
<th></th>
<th>ED</th>
<th>3 Days</th>
<th>10 Days</th>
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<tr>
<td><strong>ImPACT scores (percentile)</strong></td>
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<tr>
<td>Verbal Memory</td>
<td>30.5 (21.8–33.2)</td>
<td>30.1 (21.7–38.6)</td>
<td>28.9 (21.3–34.5)</td>
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<tr>
<td>Visual Memory</td>
<td>26.1 (18.6–34.5)</td>
<td>28.3 (20.4–36.2)</td>
<td>28.3 (20.4–36.2)</td>
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<tr>
<td>Processing Speed</td>
<td>29.5 (21.1–37.8)</td>
<td>27.6 (19.6–36.0)</td>
<td>27.1 (19.5–35.3)</td>
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<tr>
<td>Reaction Time</td>
<td>24.2 (16.2–32.1)</td>
<td>17.4 (10.3–24.5)</td>
<td>17.4 (10.3–24.5)</td>
</tr>
<tr>
<td>Impulse Control</td>
<td>15.8 (10.5–15.1)</td>
<td>22.0 (12.2–22.8)</td>
<td>22.0 (12.2–22.8)</td>
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<tr>
<td><strong>BESS Total Error score</strong></td>
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<tr>
<td>BESS Firm total</td>
<td>8.4 (6.6–10.2)</td>
<td>10.8 (8.2–13.4)</td>
<td>10.8 (8.2–13.4)</td>
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<tr>
<td>BESS Foam total</td>
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<td>BESS total</td>
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Ancillary neuropsychological tests

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<th></th>
<th>ED</th>
<th>3 Days</th>
<th>10 Days</th>
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<tr>
<td>HVLT Total Recall</td>
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<td>—</td>
<td>—</td>
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<tr>
<td>HVLT Delayed Recall</td>
<td>—</td>
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<tr>
<td>TMT A time</td>
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<tr>
<td>TMT B time</td>
<td>—</td>
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<td>—</td>
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<tr>
<td>SDMT Total Correct</td>
<td>59.9 (54.8–64.9)</td>
<td>67.6 (63.6–71.6)</td>
<td>71.5 (68.4–76.7)</td>
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<tr>
<td>LNS Total Score</td>
<td>18.5 (17.5–19.4)</td>
<td>19.0 (18.1–19.9)</td>
<td>19.7 (18.7–20.4)</td>
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<td>COWAT Total Correct</td>
<td>30.5 (27.8–33.2)</td>
<td>31.2 (28.9–33.6)</td>
<td>33.4 (30.4–36.5)</td>
</tr>
</tbody>
</table>

Data are mean (95% confidence intervals); percentile score means “percentile score” were specified, all other data are raw scores. COWAT, Controlled Oral Word Association Test; HVLT, Hopkins Verbal Learning Test; LNS, Letter-Number Sequencing; SDMT, Symbol Digit Modalities Test; TMT, Trail Making Test Parts; —, test was not done in the ED.

*a P < .05.

In patients seen in a concussion clinic, they did not demonstrate the same association between moderate and low levels of cognitive exertion and symptom duration. These studies recruited patients from the clinic setting days after injury, and thus may not generalize to the acute care setting. This current study found that patients in an acute care setting randomized to 5 days of strict rest from cognitive and physical activity experienced symptoms longer than the usual care group. Both the strict rest and usual care groups reported lower levels of cognitive activity in the first 5 days after a concussion. Taken together, these studies show that our current usual care endorsing modest physical and cognitive rest after injury is an effective strategy for recovery.

Patients in our strict rest group reported more symptoms over the course of the study. Modeling revealed that group assignment was associated with high physical symptoms early and emotional symptoms throughout the study. Given that there were not significant differences in physical activity level and small differences in cognitive activity level, it is possible some other effect of group allocation contributed to these symptom differences. Furthermore, these data do not determine whether these high symptoms represented a greater severity of illness or were simply a reporting bias. There are many potential explanations for the difference in symptom reporting. It is possible that discharge instructions influenced the perception of illness, augmenting symptom reporting. The strict rest group may have been better able to articulate their symptoms because they were slightly older. Lishman et al (1988) suggested that physiologic and psychological factors both contribute to the development of postconcussive syndrome, with psychological factors contributing more to symptoms over time. The deleterious effects of strict rest may have more to do with physiologic and psychological symptoms. Similarly, activity restrictions and lack of exercise may contribute to sleep
abnormalities and adversely affect mood. Alternatively, attending less school may have resulted in more time and fewer distractions to thoughtfully complete symptom diaries or perseverate on symptoms.

Limitations
This study had several limitations. The study focused on patients who were discharged. Because admitted patients are more likely to have significant immediate signs, they likely represent a group of interest that may have benefited from a strict rest protocol. Despite randomization, the strict rest group was older, which may have affected results. As a convenience sample of patients, our study may have favored athletes and other motivated subjects. We used diaries to record activity levels and symptom scales, which has been well validated but is subject to recall bias. Findings focus only on short-term outcomes because the majority of concussions improve within the first 7 to 10 days; however, as a result, we were unable to detect differences in subjects that recovered after the follow-up period and could not evaluate long-term outcomes.

Future Directions
More information is needed to determine the optimal discharge instructions for mTBI from the ED. Research has shown that active rehabilitation (eg, low-level physical activity) can improve outcomes in later phases of mTBI. Further research is needed to test the safety and efficacy of active rehabilitation in the acute postinjury period. Given the heterogeneity of mTBI, this question can only be answered with a large randomized controlled trial powered to detect effects on subgroups (eg, athletes, patients with previous concussions or migraines, mechanism of injury) using patient-centered outcome measures and objective neurocognitive assessments.

CONCLUSIONS
This is the first study to test recommending strict rest as an intervention to improve acute concussion outcomes in pediatric patients. In the acute care setting, we found that strict rest immediately after mTBI offers no benefit over current usual care. We also found that adolescents’ symptom reporting may be influenced by restricting activity. Further research is needed to determine the optimal ED discharge recommendations for adolescents after mTBI.

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REFERENCES


NEW LIFE FOR AN OLD BOX: I first visited London many, many years ago. At that time nobody owned a cell phone, texting had not been invented, and public telephone booths were incredibly important. I can still remember making sure I had a pocket of coins before calling my family back in the States. Today, in London as elsewhere, there is little use for the public telephone. Iconic red telephone booths (or ‘boxes’ as they are called in London) have been decommissioned and either scrapped or converted into all sorts of things— including small libraries, aquariums, and storage for emergency defibrillators. I have a friend in Vermont who has two phone boxes and uses them for a unique garden. Now a pair of English entrepreneurs has found a new use for the phone boxes: as charging stations for mobile devices. As reported in The New York Times (World: October 4, 2014), the pair won a Low Carbon Entrepreneur competition to help finance the project. The first charging station was unveiled in October 2014. The boxes were repainted green and have a solar panel on the roof. The solar panel produces enough energy to charge up to 100 phones or other mobile devices a day. There is no fee for the charging service; revenue comes from advertising displayed on a screen inside. Knowing how stressed my children become when their phones are low on power, I suspect the charging stations will be a welcome site in London. Given that there are thousands of unused telephone booths in London, the future looks bright for those short on power for their phones.

Noted by WVR, MD
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