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Original Contributions

THE DIAGNOSIS OF CONCUSSION IN PEDIATRIC EMERGENCY DEPARTMENTS: A PROSPECTIVE MULTICENTER STUDY

Kathy Boutis, MD, MSC,* Jocelyn Gravel, MD, MSC,† Stephen B. Freedman, MDCM, MSC,‡ William Craig, MDCM, MSC,§ Ken Tang, PHD,‖ Carol A. DeMatteo, MSC,¶ Alexander Sasha Dubrovsky, MDCM, MSC,# Darcy Beer, MD,** Emma Burns, MD,†† Gurinder Sangha, MD,‡‡ and Roger Zemek, MD***

*Division of Emergency Medicine, Department of Pediatrics, The Hospital for Sick Children and the University of Toronto, Toronto, Ontario, Canada, †Division of Emergency Medicine, CHU Sainte-Justine and Université de Montréal, Montréal, Québec, Canada, ‡Sections of Emergency Medicine and Gastroenterology, Department of Pediatrics, Alberta Children's Hospital and Alberta Children's Hospital Research Institute, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada, §Division of Pediatric Emergency Medicine, Stollery Children's Hospital and University of Alberta, Edmonton, Alberta, Canada, ‖Clinical Research Unit, Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, Canada, ¶McMaster University, School of Rehabilitation Science and CanChild Centre for Childhood Disability Research, Hamilton, Ontario, Canada, #Division of Emergency Medicine, Department of Pediatrics, Montréal Children's Hospital–McGill University Health Center, McGill University, Montréal, Québec, Canada, **Section of Emergency Medicine, Department of Pediatrics and Child Health, Children's Hospital of Winnipeg, University of Manitoba, Winnipeg, Manitoba, Canada, ††Department of Emergency Medicine, IWK Health Centre, Dalhousie University, Halifax, Nova Scotia, Canada, ‡‡Division of Pediatric Emergency Medicine, Department of Pediatrics, London Health Sciences Centre, Western University, London, Ontario, Canada, and ***Department of Pediatrics, Children's Hospital of Eastern Ontario, University of Ottawa, Ottawa, Ontario, Canada

Corresponding Address: Kathy Boutis, MD, MSC, Department of Pediatrics, The Hospital for Sick Children, 555 University Avenue, Toronto, ON M5G 1X8, Canada

☐ **Abstract—Background: The accurate identification of children with a concussion by emergency physicians is important to initiate appropriate anticipatory guidance and management. Objectives: We compared the frequency of persistent concussion symptoms in children who were provided the diagnosis of concussion by an emergency physician versus those who met Berlin/Zurich international criteria for this diagnosis. We also determined the clinical variables independently associated with a physician-diagnosed concussion. Methods: This was a planned secondary analysis of a prospective, multicenter cohort study. Participants were 5–17 years of age and met the Zurich/Berlin International Consensus Statement criteria for concussion. Results: There were 2946 enrolled children. In those with physician-diagnosed concussion vs. no concussion, the frequency of persistent symptoms was 62.5% vs. 38.8% ($p < 0.0001$) at 1 week, 46.3% vs. 25.8% ($p < 0.0001$) at 2 weeks, and 33.0% vs. 23.0% ($p < 0.0001$) at 4 weeks. Of those meeting international criteria, 2340 (79.4%) were diagnosed with a concussion by an emergency physician and 12 variables were associated with this diagnosis. Five had an odds ratio (OR) > 1.5: older age (13–17 vs. 5–7 years, OR 2.9), longer time to presentation (≥16 vs. <16 h, OR 2.1), nausea (OR 1.7), sport mechanism (OR 1.7), and amnesia (OR 1.6). Conclusions: Relative to international criteria, the more selective assignment of concussion by emergency physicians was associated with a greater frequency of persistent concussion symptoms. In addition, while most children meeting international criteria for concussion were also**

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provided this diagnosis for concussion by an emergency physician, the presence of 5 specific variables made this diagnosis more likely.

☐ **Keywords—concussion; diagnosis; pediatric**

INTRODUCTION

Each year in the United States, approximately 750,000 children are diagnosed with concussions in emergency departments (EDs) (1,2). While about 70% recover within a few weeks, a significant proportion experience persistent postconcussion symptoms with somatic, cognitive, psychological, or behavioral symptoms (3,4). Therefore, an accurate and timely diagnosis of concussion in the ED is important to enable clinicians to provide anticipatory guidance and initiate interventions to optimize recovery while minimizing risks (5).

To guide concussion diagnosis and management, the Zurich 4th and the Berlin 5th International Consensus statements on concussion were developed and are endorsed for use in children (6–8). Consensus statements note that a diagnosis of concussion should be made in any child receiving a direct or indirect blow to the head in which there are subsequent signs or symptoms indicative of brain dysfunction (6,7). However, applying these recommendations in the acute care setting to distinguish between concussion and isolated minor head injuries (i.e., those without brain injury) may be challenging (9). By definition, both of these are nonstructural head injuries and standard neuroimaging is normal (6). In addition, young children report symptoms differently than their older counterparts, and assessing parent/patient-reported subjective symptoms may be difficult because of limited communication skills, which may lead to under- or overdiagnosing this injury in children (7,10). Finally, there is no criterion standard (serum biomarkers or neuroimaging) to more precisely identify the presence of a concussion; therefore, it is possible that some patients who fulfill the broad Zurich/Berlin definition of concussion may actually have a more benign disease (11).

Currently, the emergency physician diagnosis of concussion vs. minor head injury remains the cornerstone for all subsequent management decisions. Yet there remains a paucity of literature that examines emergency physician decision-making with respect to how they diagnose concussion in the face of available international consensus criteria for the diagnosis of concussion. The 2 studies in this area are limited as they are single-center or based on self-reported actions (9,12). Therefore, there is a need for a prospective multicenter study that uses patient-level data to report on this emergency physician diagnostic practice.

In children who presented to a pediatric ED with a head injury, the main objective of this study was to determine the frequency of persistent concussive symptoms at 1, 2, and 4 weeks in children with and without an emergency physician–diagnosed concussion. We also examined the variables that were independently associated with an emergency physician diagnosis of concussion.

METHODS

Study Design and Setting

This was a planned secondary analysis of the Predicting Persistent Postconcussive Problems in Pediatrics (5P) study, a prospective, multicenter cohort study that recruited participants from August 2013 through June 2015 at 9 Pediatric Emergency Research Canada network tertiary care pediatric EDs (13). In these settings, EDs are staffed by pediatric emergency physicians, general emergency physicians, and pediatricians.

Study Population

Patient eligibility for the 5P study are published elsewhere (14). In brief, patients were 5–17 years of age, presented to a participating ED within 48 h of sustaining an isolated, acute head injury, and met the Zurich/Berlin international consensus concussion criteria (6,7). For this study, cases were excluded from the 5P cohort if an emeregency physician diagnostic impression was absent or there were 2 equally possible and competing primary diagnoses (e.g., “minor head injury vs. gastroenteritis”). The 5P study, with this as an approved substudy, was approved by the ethics committee of each participating institution.

Study Implementation

The full protocol is published elsewhere (14). In brief, after routine triage procedures, trained research assistants completed standardized assessments of all eligible patients before the physician assessment. Participants and parents provided information on demographics, history, and the mechanism of index head injury. They also reported injury characteristics using the Acute Concussion Evaluation (15). Both participants and parents quantified preinjury and current symptoms using the validated Post-Concussion Symptom Inventory (PCSI). Surveys were parent-reported for children 5–7 years of age and patient-reported for all other participants. Cognitive, physical examination, and balance assessments were completed