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Research article

Using simulation to identify sources of medical diagnostic error in child physical abuse

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ABSTRACT

Little is known regarding sources of diagnostic error at the provider level in cases of possible child physical abuse. This study examines medical diagnosis as part of medical management and not as part of legal investigation. Simulation offers the opportunity to evaluate diagnostic accuracy and identify error sources. We aimed to identify sources of medical diagnostic error in cases of possible abuse by assessing diagnostic accuracy, identifying gaps in evaluation, and characterizing information used by medical providers to reach their diagnoses. Eight femur fracture simulation cases, half of which were abuse and half accident, were created. Providers from a tertiary pediatric emergency department participated in a simulation exercise involving 1 of the 8 cases. Performance was evaluated using structured scoring tools and debriefing, and qualitative analysis characterized participants' rationales for their diagnoses. Overall, 39% of the 43 participants made an incorrect diagnosis regarding abuse. An incorrect diagnosis was over 8 times more likely to occur in accident than in abuse cases (OR = 8.8; 95% CI 2 to 39). Only 58% of participants correctly identified the fracture morphology, 60% correctly identified the mechanics necessary to generate the morphology, and 30% of ordered all appropriate tests for occult injury. In misdiagnoses, participants frequently falsely believed the injury did not match the proposed mechanism and the history provided by the caregiver had changed. Education programs targeting the identified error sources may result in fewer diagnostic errors and improve outcomes. The findings also support the need for referral to child abuse experts in many cases.

Introduction

Children with injuries concerning for abuse frequently present for medical care (Anderst & Dowd, 2010). In such situations, medical providers must evaluate the child for both accidental and abusive causes, including obtaining an appropriate history regarding how the injury(ies) occurred, ordering tests to evaluate for occult injuries of forensic significance, and determining the diagnosis regarding abuse (Kellogg and the Committee on Child Abuse and Neglect, 2006). Despite the serious implications of an abuse evaluation, providers often lack capabilities in identifying and managing possible child abuse (Bannon & Carter, 2003; Narayan, Socolar, & St. Claire, 2006; Shabde, 2006). These shortcomings have been attributed to inadequate training (Dubowitz, 1988; Flaherty, Sege, Hurley, & Baker, 2008; Giardino, Brayden, & Sugarman, 1998; Ward et al., 2004) and may result in misdiagnoses regarding abuse (Anderst, Kellogg, & Jung, 2009; Jenny, Hymel, Ritzen, Reinert, &

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Hay, 1999). Studies evaluating agreement regarding diagnosis of abuse between child abuse experts and non-experts identified significant differences between the two groups (Anderst et al., 2009; McGuire, Martin, & Leventhal, 2011). Additionally, racial and/or socioeconomic bias may affect how some medical providers evaluate possible abuse (Jenny et al., 1999; Lane, Rubin, Monteith, & Christian, 2002; Wood et al., 2010). Abuse misdiagnoses result in life-long consequences: an innocent caregiver may lose custody of a child and/or be incarcerated, or a child may be returned to abusive setting, risking further injury. Despite the implications of abuse evaluations, little is known regarding possible sources of diagnostic error at the provider level.

Simulation exercises offer the opportunity to identify gaps in medical provider performance in a controlled setting (Fried et al., 2004). Simulation has improved provider knowledge, skills, attitudes, and performance in other challenging medical evaluations (Hunt, Heine, Hohenhaus, Luo, & Frush, 2007; Hunt, Hohenhaus, Luo, & Frush, 2006; Maher et al., 2007). Simulation has been applied to diverse areas of medicine, including screening for interpersonal violence and adolescent depression (Gisondi, Smith-Coggins, Harter, Soltysik, & Yarnold, 2004; Knapp, Dowd, Kennedy, Stallbaumer-Rouyer, & Henderson, 2006; Lewy, Sells, Gilhooly, & McKelvey, 2009). The simultaneous use of high-fidelity simulated patients and trained standardized parents offers the opportunity to assess multiple skills in one exercise, including accuracy in diagnosis, and the learner's cognitive approach to decision-making (Ellaway, Kneebone, Lachapelle, & Topps, 2009).

Femur fractures in young children present a diagnostic challenge regarding abuse (Wood et al., 2014). As falls are one of the most common false histories provided in cases of abuse, it is necessary to obtain a detailed analysis of a fall causing a significant injury in a child (Chadwick, Chin, Salerno, Landsverk, & Kitchen, 1991; Reece & Sege, 2000; Tarantino, Dowd, & Murdock, 1999). In particular, unwitnessed injury mechanisms and the finding of additional injuries have been found to be associated with abuse (Wood et al., 2014). Conversely, a short fall may, at times, be the true cause of a child's injuries (Kaczor & Pierce, 2011; Tarantino et al., 1999). An appropriate evaluation for abuse in such cases includes a complete characterization of how the injury reportedly happened, correlating the injury mechanism to the morphology and specifics of the fracture (Kaczor & Pierce, 2011), and evaluating for the presence of other forensically significant injuries. Using simulated cases of children with femur fractures, and quantitative and qualitative analyses, we aimed to: (1) assess medical providers' diagnostic accuracy regarding abuse, (2) evaluate the associations of correct diagnosis with quality of history obtained and accuracy in fracture characterization, and (3) characterize the information used by medical providers in reaching their diagnoses.

Methods

This study was conducted in the following order: (1) simulation scenario development, (2) data collection tool development, and (3) simulation scenario assessment of participants. This study was approved by the IRB of the authors' institution.

Simulation Scenario Development

Four core simulation scenarios were designed. Correct "answers" in the scenarios were assigned by the study authors, based on actual cases encountered by the authors, and due to the clear weight of evidence regarding the correct diagnosis in the medical literature. This study approaches child physical abuse as a medical diagnosis, with diagnostic criteria based on medical literature. As stated by Boos (2006), the medical evaluation of a child who may have been abused is "part of medical management, not part of a legal investigation." This approach is supported widely throughout the medical literature and in various areas of medicine (Caneira & Myrick, 2015; Christian, 2015; Flaherty et al., 2014; Kodner & Wetherton, 2013).

Scenario 1: Accident (AC). A cruising 9 month-old child was witnessed by mom to land directly on his right knee after falling 3 feet from a bed to a hardwood floor. After hitting the knee, the child landed face down. The child settled in mom's arms, and was put down for a nap. The child's father was the next person to interact with the child, and noted the child would not bear weight on his right leg. The child was taken to an outside hospital (OSH) where an X-ray (Supplemental Fig. 1) showed a broken leg, and was then transferred to the Pediatric Emergency Department (PED) for "possible child abuse" and evaluation by a study participant. A typed summary of a social work (SW) evaluation (see below, "Social Setting") was given to the participants, along with an x-ray showing a buckle fracture of the distal right femur. The hybrid simulator (Guamard® Newborn) had a small bruise on the forehead. The physical exam was normal except a splint on the child's right leg. Any testing would reveal no other injuries, with normal laboratory values. Correct diagnosis: accidental injury (AC).

Justification for AC diagnosis in Scenario 1: The specific accidental mechanism of injury reported in this scenario has been described by Kaczor and Pierce (2011), "falls from shorter distances that involve impact to the knee most often produce a buckle fracture at the distal one third of the femur" (p. 288). This specific mechanism has been repeatedly cited in the medical literature as an accidental cause of the specific fracture included this scenario (Flaherty et al., 2014; Haney, Boos, Kutz, & Starling, 2009; Pierce et al., 2005; Pierce, Bertocci, Vogeley, & Moreland, 2008).

Scenario 2: Abuse (AB). Scenario 2 is the same as Scenario 1, except: The fall was not witnessed. If ordered by the participant, a skeletal survey would reveal two healing posterior rib fractures, elevated liver function tests (LFTs), and an abdominal CT scan would reveal a grade 1 liver laceration. Correct diagnosis: abusive injury (AB).

Justification for AB diagnosis in Scenario 2: The presence of rib fractures, particularly posterior rib fractures (as is the case in Scenario 2) is recognized as highly specific for abuse (Christian, 2015; Flaherty et al., 2014). In young children with no significant trauma history and/or no known medical skeletal dysplasia (as was the case in Scenario 2), the positive predictive value of rib fractures for child abuse has been calculated as 100% (Barsness et al., 2003). A systematic review found that the