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A two-center retrospective review of the hematologic evaluation and laboratory abnormalities in suspected victims of non-accidental injury☆

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ABSTRACT

Investigation for bleeding disorders in the context of suspected non-accidental injury (NAI) is inconsistent. We reviewed the hematologic evaluation of children who presented with symptoms of bleeding and/or bruising suspicious for NAI to determine the frequency of hematologic tests, abnormal hematologic laboratory results, and hematologic diagnoses. A retrospective cohort study design was employed at two freestanding academic children's hospitals. ICD-9 codes for NAI were used to identify 427 evaluable patients. Medical records were queried for the details of clinical and laboratory evaluations at the initial presentation concerning for NAI. The median age for the population was 326 days (range 1 day–14 years), 58% were male. Primary bleeding symptoms included intracranial hemorrhage (31.8%) and bruising (68.2%). Hematologic laboratory tests performed included complete blood cell count in 62.3%, prothrombin time (PT) in 55.0%, and activated partial thromboplastin time (aPTT) in 53.6%; fibrinogen in 27.6%; factor activity in 17.1%; von Willebrand disease evaluation in 14.5%; and platelet function analyzer in 11.7%. Prolonged laboratory values were seen in 22.5% of PT and 17.4% of aPTT assays; 66.0% of abnormal PTs and 87.5% of abnormal aPTTs were repeated. In our cohort, 0.7% (3 of 427) of the population was diagnosed with a condition predisposing to bleeding. In children with bleeding symptoms concerning for NAI, hemostatic evaluation is inconsistent. Abnormal tests are not routinely repeated, and investigation for the most common bleeding disorder, von Willebrand disease, is rare. Further research into the extent and appropriate timing of the evaluation is warranted.

Introduction

Child maltreatment is a frequent and devastating phenomenon throughout the United States. In 2011, there were over 3 million instances of suspected child maltreatment, approximately 20% of which were the result physical abuse or

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non-accidental injury (NAI; U.S. Department of Health and Human Services, 2011). Bruising is the most common presenting symptom in physical abuse (Johnson & Showers, 1985), and abusive head trauma, including intracranial hemorrhage (ICH), is the most common cause of death resulting from physical abuse (Duhaime et al., 1992; Kellogg, 2007). Bleeding disorders are estimated to exist in as much as 1% of the general population; for von Willebrand disease, the most common minor bleeding disorder, the estimations of prevalence within the general population range from 0.6 to 1.3% (Nichols et al., 2008). When bleeding disorders are identified in children who present with bruising or bleeding, the perceived likelihood of abuse could be altered dramatically. Incorrectly diagnosing NAI is potentially life altering for the child and family (Kocher & Dichtel, 2011). Despite the high incidence of NAI and the relative high aggregate prevalence of bleeding disorders, few studies have evaluated the frequency of bleeding disorders in children who have bleeding/bruising concerning for NAI.

Medical understanding of children suspected of child maltreatment has evolved since Kempe identified Battered-Child Syndrome in his 1962 manuscript (Kempe, Silverman, Steele, Droegemueller, & Silver, 1962). Victims of NAI have been identified as having both true bleeding diatheses and unexplained coagulation laboratory abnormalities (O'Hare & Eden, 1984). In a population of non-accidental head trauma patients, prolonged PT, decreased fibrinogen, and decreased platelet counts were associated with parenchymal brain damage (Hymel, Abshire, Luckey, & Jenny, 1997). Despite these associations, neither the frequency of coagulation laboratory abnormalities in the setting of NAI nor the pathophysiology of these changes have been extensively studied. The optimal hematologic evaluation of NAI is not well defined despite expert opinion-based publications (Liesner, Hann, & Khair, 2004; Minford & Richards, 2010; Thomas, 2004). More recently, the American Academy of Pediatrics (AAP) published guideline recommendations for the hematologic evaluation of children with suspected NAI. These recommendations are expert opinions based on clinical presentation and prevalence of bleeding disorders in the general population, and thus could benefit from research directly focused on the NAI population (Anderst, Carpenter, & Abshire, 2013). Increased evidence is needed to further clarify the optimal evaluation for bleeding disorders in suspected NAI. Additionally, the pathophysiology of acquired hematologic abnormalities in NAI is unknown, particularly in cases involving head trauma.

To further investigate the hematologic findings in children suspected of experiencing NAI, we conducted a two-center retrospective cohort study. Our objectives for this study were: (a) to determine the frequency and extent of a hematologic evaluation performed in children with intracranial hemorrhage and/or bruising and concern for NAI, (b) to determine the frequency of abnormal coagulation laboratory studies at the time of acute injury and the frequency of follow-up of those abnormal tests, and (c) to determine the frequency of hematologic diagnoses within this population.

Methods

A retrospective observational study design was utilized. Potential participants for the study were identified by query of hospital billing data at two tertiary care children's hospitals from January 2007 through March 2012 and November 2009 through December 2011, respectively, for ICD-9 codes for child physical abuse (995.5, 995.50, 995.54, 995.55, 995.59). Inclusion criteria consisted of the following: age less than 18 years at presentation, clinical presentation concerning for NAI defined as referral for evaluation of child abuse, and clinical presentation including bleeding or bruising. Children with a known history of bleeding disorder prior to initial presentation were excluded. Institutional Review Board approval was obtained for this study at Vanderbilt University in Nashville, TN, and Children's Mercy Hospitals and Clinics in Kansas City, MO.

Data were collected by medical record review and relevant information was entered into REDCap™, a secure, web-based application for building and managing online surveys and databases (Vanderbilt University, 2012). Extracted data included both clinical history and laboratory evaluation from the initial hospital encounter (emergency department visit, plus admission when applicable); follow-up outpatient clinical or laboratory testing was not included. Clinical data consisted of details of the patient's initial presentation, including physical examination and imaging studies, hematology assessment, admission to general pediatric ward or intensive care unit, and discharge disposition. Bleeding symptoms (e.g., bruising or ICH) were noted based on reported physical exam findings and imaging studies. For analysis purposes, bruises, as documented in the physical examination section of the history and physical reports within the medical record, were categorized by the study team as concerning for NAI versus non-concerning for NAI (Table 1; Anderst et al., 2013; Jackson, Carpenter, & Anderst, 2012). Laboratory data recorded included complete blood count (i.e., differential and smear review, kidney and liver function tests, PT, aPTT, fibrinogen, coagulation factor activity levels, von Willebrand antigen, ristocetin cofactor activity and multimer analysis, platelet function analyzer (PFA-100®), and evaluation for defects in fibrinolysis [e.g., plasminogen activator inhibitor 1 activity, alpha-2-antiplasmin activity]). Data were collected at initial presentation and associated hospital admission. Patient mortality and/or disposition were also assessed. *A priori*, we defined both a basic and comprehensive hematologic evaluation for both bruising and ICH based on testing for the most common bleeding disorders. We defined a basic hematologic evaluation as a CBC, PT, and aPTT. We defined a comprehensive hematologic evaluation as CBC, PT, aPTT, factor VIII, factor IX, and von Willebrand disease panel. Laboratory values were defined as abnormal if they were outside the normal reference ranges for the hospital laboratory; hematology and chemistry laboratory values were age-based reference ranges, and coagulation laboratory values were based on adult reference ranges.

Data were analyzed using SPSS version 20. Descriptive analyses included demographic information and the frequency of individual laboratory tests, hematologic diagnoses, and intensive care admission. Descriptive analyses for continuous variables included mean, median, maximum and minimum values, and standard deviation when the data were normally