

# Evaluation of an Emergency Department High-risk Bruising Screening Protocol

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abstract

**OBJECTIVES:** The objective of this study was to describe the outcomes of implementing a high-risk bruise screening pathway in a pediatric emergency department (ED).

**METHODS:** A retrospective observational study was performed of children aged 0 to <48 months who presented to the ED between December 1, 2016, and April 1, 2019, and had bruising that is high-risk for physical abuse on a nurse screening examination. A high-risk bruise was defined as any bruise if aged <6 months or a bruise to the torso, ears, or neck if aged 6 to <48 months. Records of children with provider-confirmed high-risk bruising were reviewed.

**RESULTS:** Of the 49 726 age-eligible children presenting to the ED, 43 771 (88%) were screened for bruising. Seven hundred eighty-three (1.8%) of those children had positive screen results and 163 (0.4%) had provider-confirmed high-risk bruising. Of the 8635 infants aged <6 months who were screened, 48 (0.6%) had high-risk bruising and 24 of 48 (50%) were classified as cases of likely or definite abuse. Skeletal surveys were performed in 29 of 48 (60%) infants, and 11 of 29 (38%) had occult fracture. Of the 35 136 children aged 6 to <48 months who were screened, 115 of 35 136 (0.3%) had high-risk bruising and 32 of 115 (28%) were classified as cases of likely or definite abuse.

**CONCLUSIONS:** High-risk bruising was rarely present. When infants aged <6 months were evaluated per recommendations, occult fracture was identified in one-third of patients. The screening pathway could help other institutions identify occult injuries in pediatric ED patients.



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**WHAT'S KNOWN ON THIS SUBJECT:** Bruising in infants aged <4 to 6 months and bruises on the torso, ears, or neck in children aged <48 months has been revealed to be associated with abusive injury.

**WHAT THIS STUDY ADDS:** We describe the results of implementing an emergency department process to formally screen for high-risk bruising and perform an age-appropriate workup for abusive injuries in those with positive screening results. High-risk bruising was rarely found despite a large sample screened.

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Abuse-related injuries should be promptly identified to protect children from repeated abuse and even death. Bruising in young children may be the earliest or only sign of physical abuse.<sup>1–13</sup> Bruising has been associated with occult head injury, fractures, and abdominal trauma in young children.<sup>3,5,6,14–17</sup> Experts recommend that children aged <2 years with physical abuse concerns have a skeletal survey performed to evaluate for occult fractures.<sup>18,19</sup> These children may also need head imaging to screen for abusive head trauma, although the exact recommended age for routine screening varies.<sup>3,5,14–16,18,19</sup> It has been proposed that children with physical abuse concerns should be screened for occult abdominal trauma with transaminase and lipase testing.<sup>3,20,21</sup>

In several previous studies, researchers have characterized bruising patterns sustained in accidental trauma, as well as medical conditions, such as bleeding disorders.<sup>2,6–11,22–25</sup> Several groups have developed memorable guidelines for areas of bruising concerning for physical abuse.<sup>4,6–8,13,24,26</sup> The bruising clinical decision–rule mnemonic “TEN-4” is one tool used to identify high-risk bruising<sup>8</sup> and refers to bruising on any part of the body in children aged <4 months and bruising on the torso, ears, and neck (TEN) in children aged ≤4 years. No institution has published the results of using this tool to create a routine screening process for high-risk bruising.

In 2016, in response to missed sentinel bruises on patients who went on to have poor outcomes, a clinical standard work pathway was developed at Seattle Children’s Hospital (SCH) to screen for high-risk bruising in all children presenting to the pediatric emergency department (ED). The purpose of this study was to describe the

outcomes of implementing a pediatric ED high-risk bruising screening process.

## METHODS

### Pathway Creation

Pathway development followed the standard hospital process, which involves an in-depth literature review, local consensus building, systems testing, and buy-in from multiple departments and stakeholders. Other clinical standard work research at our institution has been published.<sup>27,28</sup>

The pathway team modified the TEN-4 clinical decision rule to define what would constitute a positive screen result. The age of concern for any bruise was defined as <6 months because previous research suggests that any bruise may be concerning in all premobile infants.<sup>2,3,5,6,11</sup> Bruising in the TEN area was defined as high risk for children aged <48 months. Nurse skin-screening examinations were limited to high-risk areas as defined by the modified TEN-4 clinical decision rule. However, pathway documentation states that any patient with concerning bruising could follow pathway recommendations. For the pathway, a standard medical evaluation in children with high-risk bruising consisted of (1) a head computed tomography (CT) scan for children aged <6 months or with neurologic symptoms, (2) a skeletal survey for children aged <24 months, and (3) blood work to screen for bleeding disorders and abdominal trauma (Fig 1 c footnote). A written guideline for the pathway was published online.<sup>29</sup> Staff members were trained on the screening process before implementation. The screening process protocol is standard for all ED patients (Fig 1). Nurses perform the initial screening skin examination and document any bruising characteristics. A “pop-up reminder” of a bruising screen with positive results was added to the Cerner

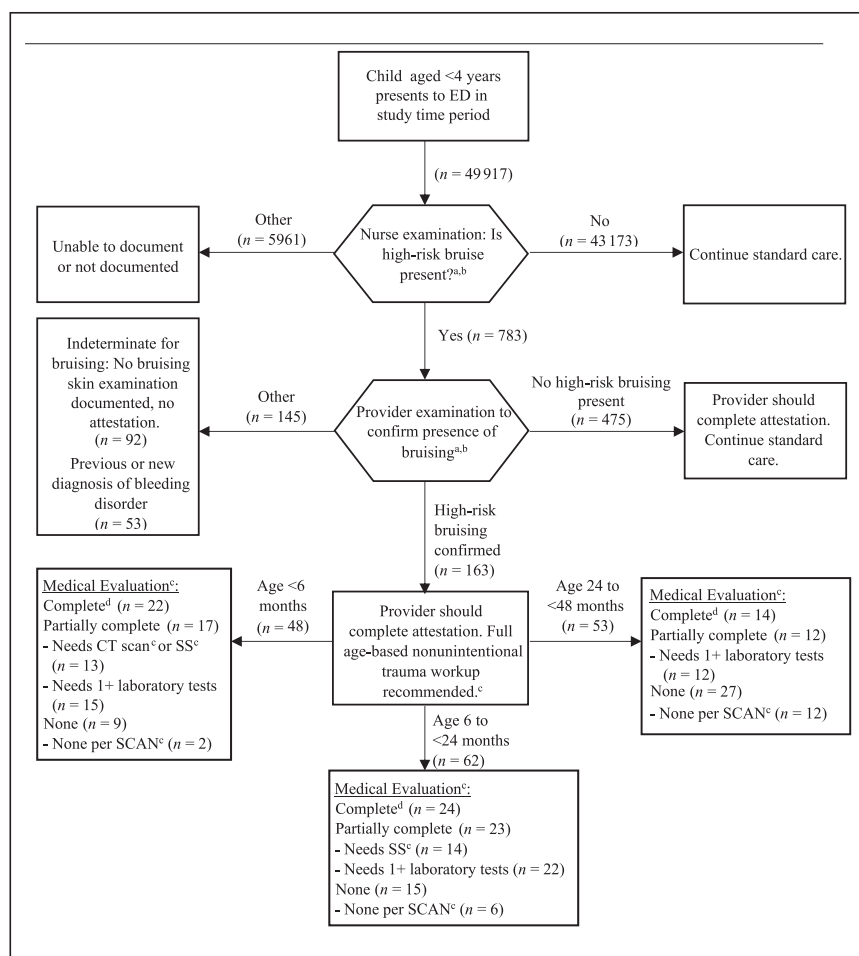
medical record in 2018, midway through the study period. The pop-up screen requests that the attending or fellow physician select a case response option and provide a written attestation to the positive screen result (supplement 1). Before this pop-up was introduced, it was assumed that providers would document their acknowledgment of the screening in the ED note.

### Study Design and Population

This retrospective observational study was performed at SCH’s pediatric ED. The ED provides care for ~50 000 children each year. SCH is 1 of 2 pediatric quaternary care hospitals in the geographic region and is a level 2 trauma center.

### Medical Record Review

A retrospective medical record review was conducted for all patients aged 0 to <48 months with a positive screen result. Screening results were collected from December 1, 2016 (1 week after start of the pathway), to April 1, 2019. High-risk bruising was defined, for purposes of chart review per the pathway design, as any bruise in a child aged <6 months or a bruise to the TEN in a child aged 6 to <48 months. Bruising over the spine in children aged >6 months was not defined as high risk. After review of the medical record, the principal investigator (C.E.C.) categorized every patient with a positive bruising screen result. High-risk bruise was assigned to patients for whom high-risk bruising was confirmed in documentation by a provider (physician or nurse practitioner). Indeterminate for bruising was assigned to patients for whom no skin examination for bruising or attestation was documented by a provider. No high-risk bruise was assigned to patients for whom a provider specifically documented that no high-risk bruise was present. Children with a bleeding disorder



**FIGURE 1**

High-risk bruise screening process. The screening process is stepwise, with nursing staff performing the initial examinations. Senior-provider skin examinations improve specificity of the process. Children without high-risk bruises receive standard care. <sup>a</sup>The nurse performs a full skin examination in children <6 months of age and a skin examination of the TEN in children 6 months to 4 years of age. The genital skin examination in children >6 months of age is deferred to the provider. <sup>b</sup>A high-risk bruise for age is defined as a bruise anywhere in a child <6 months of age or a bruise on the torso, ears, or neck in a child 6 months to <4 years of age. The genital area and buttocks are part of the torso. <sup>c</sup>For medical evaluation, all patients receive abdominal trauma screening labs (aspartate aminotransferase [AST], alanine transaminase [ALT], lipase, urinalysis) and bleeding disorder screening labs (CBC, PT, INR, PTT, VWf). Children less than 2 years of age have a skeletal survey. Children less than 6 months of age have head imaging by CT or MRI. Head imaging or skeletal survey (SS) is done in older children if indicated. In addition to the standard medical testing, social work consult, child abuse specialist (SCAN team) consult, and photographs are recommended. <sup>d</sup>Medical evaluations were considered complete for purposes of the study if they were only missing urinalysis testing, because this test was later changed to an “optional” recommendation. SCAN, Safe Child and Adolescent Network.

were excluded from analysis at this point (see “special considerations and definitions”).

If a patient was classified as high-risk bruise or indeterminate for bruising, a total of 53 unique variables were abstracted from the medical record, as applicable. Study data were

collected and managed by using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of Washington.<sup>30,31</sup> Variables abstracted included demographic characteristics, injury characteristics and history, laboratory and/or radiology results, and social service reporting records.

All the records were reviewed by the same reviewer.

Approval from the SCH Institutional Review Board was obtained and maintained during data collection and analysis.

## Expert Review

All children with high-risk bruising were presented in vignette form to a group of 6 board-certified pediatricians with experience or board-certification in child abuse. These providers were part of the hospital’s child abuse consulting team. The vignettes included the age and sex of the child, a developmental level if available, presenting injury, photographs of injury if available, the reported mechanism of injury, other injuries, and the results of any screening tests. No information about socioeconomic status or race and/or ethnicity was provided in the vignette. Vignettes were reviewed as a group in real time, with anonymous voting on level of concern for abuse performed for each child on a 5-point scale (definite accidental injury and/or medical condition, likely accidental injury and/or medical condition, indeterminate for abuse, likely abuse, and definite abuse). This scale was designed for this study on the basis of a Likert scale, which is commonly used in assessment. Previous researchers have studied other scales of child abuse likelihood,<sup>32</sup> but these scales (including the 7-point likelihood scale) were felt to be too finely detailed to assess the limited information available in the patient vignettes. A pediatrician’s decision to select a rating was based on their assessment of the patient vignette. Use of “definite” versus “likely” was discussed, but no formal definitions were given. After anonymous voting was completed, the level of concern for abuse score was assigned as the most common rating. If a tie was identified for 2 levels of concern, the results were resolved via discussion.

**TABLE 1** Results of Screening Protocol and Chart Review

Age	Seen in ED, <i>n</i>	Screened for Bruising, <i>n</i> (% of Seen)	Positive Screen Results, <i>n</i> (% of Screened)	Provider-Confirmed High-risk Bruise, <i>n</i> (% of Screened)
<6 mo	9276	8635 (93.1)	141 (1.6)	48 (0.6)
6 to <12 mo	8073	7220 (89.4)	109 (1.5)	16 (0.2)
12 to <2 y	14 244	12 446 (87.4)	251 (2.0)	46 (0.4)
2 to <4 y	18 133	15 470 (85.3)	282 (1.8)	53 (0.3)
Total	49 726	43 771 (88)	783 (1.8)	163 (0.4)

### Special Considerations and Definitions

For this study, an occult fracture was defined as a fracture with no clinical symptoms. Repeat skeletal surveys were performed ~2 weeks after the initial skeletal survey. A skeletal survey with positive results was defined as a skeletal survey in which at least 1 fracture was identified.

Children with previously diagnosed bleeding disorders and children with bleeding disorders diagnosed or highly suspected at the time of encounter were excluded from analysis. The principal investigator (C.E.C.) confirmed reasonable historical indicators (eg, taking anticoagulants) or abnormalities in the standard bleeding disorder screen performed in the ED (complete blood count [CBC], prothrombin time [PT], international normalized ratio [INR], partial thromboplastin time [PTT],

and von Willebrand factor antigen [VWFa]).

High-risk bruising, for purposes of pathway analysis, was defined on the basis of a child's age and the location of the bruising, as previously noted. Patterned bruising and bruising in other areas can also be high risk for age.

### Analyses

Analyses were performed by using Microsoft Excel and by using Stata statistical software: release 14 (Stata Corp, College Station, TX).

## RESULTS

### All Ages

Of the 49 726 children aged <48 months presenting to the ED in the study time period, 43 771 (88%) were screened for bruising. Of those screened, 783 children (1.8%) had a high-risk bruise documented as

present on initial nurse examination. A provider documented confirmation of the high-risk bruising in 163 of 43 771 children (0.4%) (Table 1). These 163 children did not have a suspected or confirmed bleeding disorder. Children with highly suspected or confirmed bleeding disorders (*n* = 53) are excluded from all tables and analysis except where noted. Demographic characteristics of all children with positive screen results are presented in Table 2 and separated by the principal investigator case classification. In Table 3, we describe the number of children who received the recommended bleeding disorder and abdominal trauma screening blood work and the ranges of results for each test.

### Less Than 6 Months of Age: Pathway and Evaluation Outcomes

In the group of infants aged <6 months, the presence of any bruise

**TABLE 2** Demographics

	High-risk Bruise ( <i>n</i> = 163)	Indeterminate for Bruising ( <i>n</i> = 92)	No High-risk Bruise ( <i>n</i> = 475)	Total ( <i>n</i> = 783)
Age, mo, <i>n</i> (%) <sup>a</sup>				
<6	48 (30)	16 (17)	72 (15.2)	141 (18)
6 to <12	16 (10)	15 (16)	76 (16)	109 (13.9)
12 to <24	46 (28)	30 (33)	158 (33.3)	251 (32.1)
24 to <48	53 (33)	31 (34)	169 (35.6)	282 (36)
Boys, <i>n</i> (%) <sup>a</sup>	98 (60)	56 (61)	276 (58.1)	468 (59.8)
Reported race, <i>n</i> (%) <sup>a</sup>				
White	99 (61)	53 (58)	193 (40.6)	371 (47.4)
Black or African American	4 (3)	3 (3)	40 (8.4)	47 (6)
Asian	12 (7)	6 (7)	64 (13.5)	89 (11.4)
Other	30 (18)	20 (22)	122 (25.7)	187 (23.9)
Multiple	18 (11)	10 (11)	53 (11.2)	86 (11)
Hispanic or Latino, <i>n</i> (%) <sup>a</sup>	36 (22)	18 (20)	112 (23.6)	174 (22.2)
Privately insured, <i>n</i> (%) <sup>a</sup>	56 (34)	43 (47)	162 (34.1)	279 (35.6)

Numbers may not add up to column total if respondents refused to answer. Numbers may not add up to row total because patients with a bleeding disorder (*n* = 53) were included in the total.

<sup>a</sup> Percentage is of total *n* for bruise group (high-risk bruise, indeterminate, no high-risk bruise, or total).

**TABLE 3** Children With Provider-Confirmed High-risk Bruising, Number Receiving and Results of Bleeding Disorder and Abdominal Trauma Screening Laboratory Testing

Test <sup>a</sup>	<6 mo (n = 48)	6 to <12 mo (n = 16)	12 to <24 mo (n = 46)	24 to <48 mo (n = 53)
AST, IU/L, n (range)	27 (25–93)	8 (40–86)	23 (36–58)	19 (22–76)
ALT, IU/L, n (range)	30 (28–76)	9 (25–52)	26 (13–58)	23 (18–75)
Lipase, IU/L, n (range)	29 (<3–141)	9 (23–90)	23 (<10–252)	22 (<10–114)
Urinalysis, n (% with blood present)	25 (20)	7 (14.3)	17 (11.8)	19 (5.3)
CBC, n (platelet range)	35 (258–648)	9 (189–381)	28 (157–509)	24 (207–533)
PT, s, n (range)	32 (11.9–15.7)	9 (11.6–13.3)	23 (12.6–16.2)	24 (12.8–14.8)
INR, n (range)	32 (0.9–1.2)	9 (0.9–1.0)	22 (1.0–1.3)	24 (1.0–1.2)
PTT, s, n (range)	31 (26–44)	9 (29–36)	23 (22–41)	24 (23–40)
VWFa, %, n (range)	27 (65–259)	8 (59–243)	18 (62–202)	15 (49–211)

Children with known bleeding disorders or disorders diagnosed or highly suspected because of coagulation abnormalities in the same encounter were excluded. ALT, alanine aminotransferase; AST, aspartate aminotransferase.

was rare. Of the 8635 children screened, 48 (0.6%) were confirmed to have a high-risk bruise and 16 (0.19%) were indeterminate for the presence of a high-risk bruise (Table 1).

Head injuries were present in the group of infants aged <6 months (Table 4). Of the children with high-risk bruising in this age group, 30 of 48 (63%) had a head CT scan performed, as recommended by the pathway. Of those who had a CT scan, 7 of 30 (23%) had an intracranial or skull injury.

Outcomes of skeletal surveys in this age group are presented in Table 5. Of the 48 children who were confirmed by a provider to have a high-risk bruise, 29 (60%) had a skeletal survey performed. Of those who had a skeletal survey, 11 (38%) had fractures. A repeat skeletal survey was performed in 19 of 29 (66%) children who had an initial skeletal survey. In the repeat skeletal survey,

previously unnoticed fracture(s) were identified in 6 of 19 (32%) infants.

#### Less Than 6 Months of Age: Occult Injury

Among the 15 infants aged <6 months with fractures and/or intracranial injuries, 7 (47%) had only clinically occult fractures or intracranial injuries (Tables 4 and 5). If providers had not performed further imaging on the basis of the high-risk bruising, these children would not have had other injuries identified.

#### Less Than 6 Months of Age: Expert Level of Concern for Abuse and Reporting

Children aged <6 months with high-risk bruising were most commonly assigned an expert level of concern for abuse of definite abuse (Fig 2). Of the 12 infants aged <6 months with initial or repeat skeletal surveys with fracture, 10 (83%) were rated by a group of child abuse experts as

likely or definite abuse. The remaining infants represented 1 verified birth injury and 1 witnessed fall with injuries that were consistent with the provided story. For infants with skull fracture or intracranial findings, 5 of 7 (71%) had their overall presentation rated as definite abuse by a group of child abuse experts. The remaining 2 infants represented 1 verified birth injury (the same infant as described above) and 1 witnessed fall.

A report was made to Child Protective Services (CPS) and law enforcement (LE) for 81% of children aged <6 months with a high-risk bruise (Table 6).

For all infants aged <6 months, including those without an abuse workup, the presence of any bruise had a positive predictive value of 27% for occult fracture or intracranial abnormality and a positive predictive value of 50% for a concern for abuse of likely abuse or definite abuse by the group of child abuse experts.

#### Less Than 6 Months of Age: Children Without Skeletal Survey

There were 19 ED visits in which infants had high-risk bruising and did not have a skeletal survey performed, representing 18 unique infants. Caregiver explanations for bruising in this group included witnessed falls (8 visits), self-sucking bruise (1 visit), motor vehicle collisions (2 visits), recent circumcision (1 visit), sibling bite (1 visit), verified birth injury (2 visits), and unknown and/or other (4 visits). For 6 of 19 (32%) of these infants, the child abuse team was contacted during the visit and agreed with a plan for no abuse workup.

#### Six to <48 Months of Age: Pathway and Evaluation Outcomes

Of the children who presented to the ED who were aged 6 to <48 months, 35 136 (86.9%) were screened for high-risk bruising. Of those screened, 642 (1.8%) had positive screen

**TABLE 4** Outcome of Head Imaging Screening for Different Age Groups

Age, mo	Positive for High-risk Bruise, n	Head CT Scan Performed, n (%) <sup>a</sup>	Brain MRI Performed, n (%) <sup>a</sup>	Head CT Scan With Skull Fracture, n (%) <sup>b</sup>	Head CT Scan With Intracranial Abnormality, n (%) <sup>b</sup>	Head CT Scan With Any Intracranial or Skull Abnormality, n (%) <sup>b</sup>
<6	48	30 (63)	3 (6)	4 (13)	5 (17)	7 (23)
6 to <48	115	18 (16)	0 (0)	0 (0)	0 (0)	0 (0)

<sup>a</sup> Percentage for column is percentage of total in age group with a high-risk bruise.

<sup>b</sup> Percentage for column is percentage of children who had a head CT scan performed.



**TABLE 5** Outcome of Skeletal Survey Imaging for Different Age Groups

Age, mo	Total Children Positive for High-risk Bruise, <i>n</i>	Skeletal Survey Done, <i>n</i> (%) <sup>a</sup>	Initial Skeletal Survey With Positive Results, <i>n</i> (%) <sup>b</sup>	Children With Occult Fracture, <i>n</i> (%) <sup>b</sup>	Repeat Skeletal Survey Done, <i>n</i> (%) <sup>b</sup>	Repeat Skeletal Survey With Previously Unnoticed Fracture, <i>n</i> (%) <sup>c</sup>
<6	48	29 (60)	11 (38)	10 (35)	19 (66)	6 (32)
6 to <12	16	8 (50)	1 (13)	0 (0)	1 (13)	0 (0)
12 to <24	46	25 (54)	4 (16)	1 (4)	3 (12)	0 (0)
24 to <48	53	11 (21)	2 (18)	0 (0)	1 (9)	0 (0)

<sup>a</sup> Percentage for column is percentage of total in age group with a high-risk bruise (value to far left).

<sup>b</sup> Percentage for column is percentage of children who had an initial skeletal survey done.

<sup>c</sup> Percentage for column is percentage of children who had a repeat skeletal survey done.

results. Providers confirmed high-risk bruising was present in 115 of 35 136 (0.33%) of the children with positive screen results (Table 1). In this age group, skeletal survey was less commonly performed as recommended, and when performed, less likely to have positive findings (Tables 4 and 5).

#### Six to <48 Months of Age: Expert Level of Concern for Abuse and Reporting

Children aged ≥12 months were most commonly assigned a level of concern for abuse rating of indeterminate for abuse (Fig 2). Of the 115 children aged 6 to <48 months with high-risk bruising, 18 (16%) were reported to CPS, LE, or both by hospital staff. For children

aged 6 to <48 months, the presence of a high-risk bruise had a positive predictive value of 28% for a child abuse expert concern for abuse of likely abuse or definite abuse.

#### Six to <48 Months of Age: Occult Injury

A single child between 12 and 24 months of age in this group had occult fracture identified by skeletal survey. No child in this age group had intracranial injury or skull fracture identified on head CT scan.

#### DISCUSSION

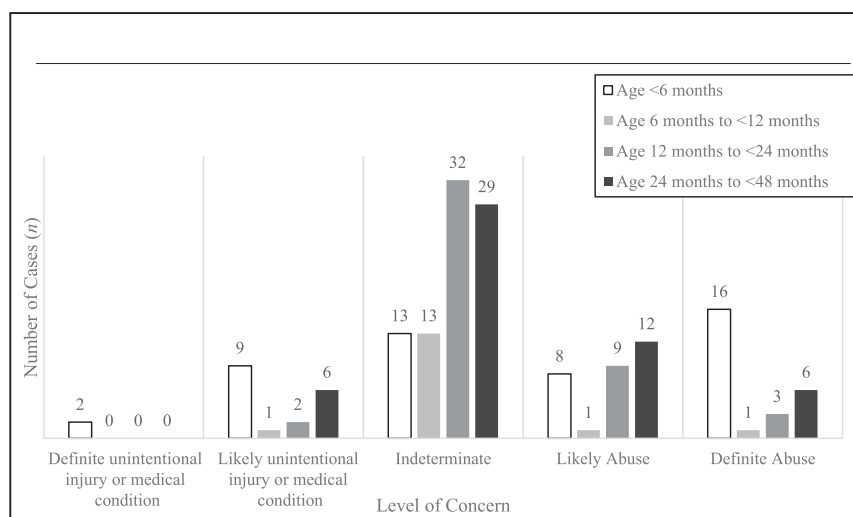
Consistent with previous studies, we found that high-risk bruising is uncommon. In a previous study in primary care offices, researchers

found that the prevalence of any bruise in children aged <6 months was 0.6%.<sup>11</sup> This was the same as our prevalence in this age group of 0.6%.

Our sample of children evaluated via imaging was small, limiting the accuracy of direct comparisons. Of the infants aged <6 months in our study who had an initial skeletal survey, the prevalence of at least 1 fracture was 38%. In previous literature, researchers have cited a prevalence of 23.3% in this age group.<sup>3</sup> Our prevalence of skull fracture and/or intracranial injury (23%) among children who had a head CT scan in the group of children aged <6 months can be reviewed in the context of previous estimations of 9.7% to 20.5%<sup>14,33</sup> for occult head injury and 27.4%<sup>3</sup> for any head injury in this age group.

For children in the 6-month to 4-year age group, the prevalence of high-risk (TEN) bruising was low as well, at 0.33%. This finding reveals that TEN bruising is not commonly seen in this age group and should prompt an evaluator to consider child abuse or a medical etiology as a cause of bruising. Screening for other injuries was limited by provider adherence to pathway guidelines.<sup>29</sup> Abuse ratings for this group were most commonly indeterminate for abuse, likely because of increasing developmental abilities and the limited workups conducted.

Of the children who were initially screened onto the pathway for concern for high-risk bruising by a nurse examination, 59.9% (475 of

**FIGURE 2**

Level of concern for high-risk bruises by child abuse experts. Child abuse experts rated each patient on their level of concern that the presenting injuries were abusive. The results are displayed, with stratification based on age group.

**TABLE 6** CPS and LE Reports Made in ED for Children With Confirmed High-risk Bruise

Age, mo	CPS Report, <i>n</i>	LE Report, <i>n</i>	Total Reports, <i>n</i> (% of age group)
<6 ( <i>n</i> = 48)	23	16	39 (81)
6 to <12 ( <i>n</i> = 16)	3	0	3 (19)
12 to <24 ( <i>n</i> = 46)	8	2	10 (22)
24 to <48 ( <i>n</i> = 53)	8	2	10 (19)
All ages ( <i>n</i> = 163)	42	20	62 (38)

Children who already had CPS or LE reports at the time of presentation were not included in these totals. The ED standard process is to make new reports if concerns are identified in the ED, regardless of previous reports. It is also typically standard to report all bruising in infants to both CPS and LE.

793) were documented by a provider to not have high-risk bruising. False-positive explanations were approximately equally divided between birthmarks, other injuries that were not bruises, unintentional selection of the button for positive screen results, and bruising not in high-risk areas for age. The number of screens with false-positive results was high but should be reviewed in context of the successful screening of 88% of ~50 000 children over the study time period. In one study of an ED-based child abuse screening checklist in the Netherlands, there was a 67% screening rate despite a legal mandate for screening.<sup>34</sup> In another study of a validated electronic health record child abuse screen in Pittsburgh, there was a 68% successful screen rate.<sup>35</sup>

**Limitations**

A limitation for this study is the children who were not screened for high-risk bruising. It is difficult to perform a skin examination on high-acuity patients or on older, lower-acuity patients when the ED has a high census and the ratio of nurses to patients decreases. In a similar consideration, there is likely an unknown number of children with high-risk bruising who were screened incorrectly as no high-risk bruising present by nursing staff and not reviewed. We attempted to mitigate this by extensive teaching before

implementation, as well as a mandate to have all children younger than age 4 years put into a hospital gown. Even when nursing staff did document a positive screen result, workup was limited if providers did not acknowledge the screen because of the challenging dynamic nature of the ED workflow. The number of patients with the rating indeterminate for bruising would have been smaller had providers completed the pop-up reminder attestation. Some children did not receive an age-appropriate evaluation for other injuries when a high-risk bruise was present. The lack of workup in these children likely biases our positive predictive value calculations. ED provider compliance with evaluation recommendations could be improved.

Our study also does not include a preimplementation or control sample for comparison purposes because our hospital did not consistently identify cases of high-risk bruising before pathway implementation. The lack of comparison data for our sample limits our ability to draw conclusions about previously missed abuse. However, the results can be used to speak to the value of having a routine process to screen and evaluate high-risk bruising.

A final limitation is that the child abuse experts assigned to review the cases were part of the child abuse team at the hospital. This could have

created anchoring bias for the consulting provider for the case, although anonymous averaged voting may have decreased anchoring.

**CONCLUSIONS**

There was moderate adherence to pathway recommendations. Screening for high-risk bruising in the ED identified cases of child physical abuse that otherwise would have been missed. Bruising was rare in infants aged <6 months and, when present, was accompanied by fracture in over a third of children with an abuse workup. This pathway may be effective for other institutions, including general EDs in which pediatric skin examinations may be less of a focus.

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**ABBREVIATIONS**

CBC: complete blood count  
CPS: Child Protective Services  
CT: computed tomography  
ED: emergency department  
INR: international normalized ratio  
LE: law enforcement  
PT: prothrombin time  
PTT: partial thromboplastin time  
SCH: Seattle Children's Hospital  
TEN: torso, ears, and neck  
VWFa: von Willebrand factor antigen

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**POTENTIAL CONFLICT OF INTEREST:** Drs Crumm, Brown, Metz, and Feldman provide legal consultation and testimony in child abuse cases. Drs Feldman and Metz have received financial compensation for consultation or legal testimony in child abuse cases.

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