Fractures in young children: Are physicians in the emergency department and orthopedic clinics adequately screening for possible abuse?

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Objectives: 1) To determine whether physicians are sufficiently investigating the cause of fractures in children younger than 3 years and 2) to find out what influences physicians' quality of history taking and documentation necessary to rule out inflicted trauma.

Design: Descriptive, retrospective chart review.

Setting: Pediatric emergency department and orthopedic clinic of an urban teaching hospital.

Subjects: Children younger than 3 years treated between January 1, 1995, and December 31, 1998, presenting with a fracture.

Results: A total of 653 charts met entry criteria. Information that was significantly lacking in the recorded history included witness presence, history of previous injury, review of past medical record, other injury description, and whether the injury was consistent with the development of the child. It was not possible to rule out inflicted injury in 42% of the patients. Four groups emerged from the entire cohort: group 1, accidental trauma, which made up 63% of the entire group ($n = 413$); group 2, inflicted trauma, which made up 13% ($n = 85$); group 3, missed inflicted trauma, which made up 23% ($n = 151$); and group 4, missed accidental trauma, which made up 0.6% ($n = 4$). Younger age of the child, multiple fractures, need for hospital admission, and the examining physician being a pediatrician positively influenced physicians' propensity to accurately report inflicted trauma.

Conclusions: A large percentage of the charts reviewed contained inadequate documentation to explain the cause of fractures and thereby rule out inflicted trauma. Information in 23% of the charts reviewed aroused suspicion of inflicted trauma. There is a need to ensure that adequate information is obtained and documented in hospital records to rule out inflicted injury. This will require changes in the knowledge, skills, and attitudes of physicians. The use of forms, protocols, and periodic chart review will help to ensure compliance.

INTRODUCTION

Child abuse and neglect became a visible issue after the first reports of abuse, which date back to the 1940s, the most notable of which was by Caffey (1), who was a radiologist. Victims of physical abuse comprise the second largest portion (25%) of children suffering from child abuse and neglect (2). Of that group, fractures are the result of abuse in about one third, although figures vary from 11 to 55% (3, 4). Physical abuse is responsible for 15 to 30% of fractures occurring in children aged 3 years or younger (2–6); however, it may be responsible for almost all of certain types of fractures, such as rib fractures in infants (7).

It has been reported that 35% of abused children will be abused again if there is no intervention, and 5 to 10% of them will die (3–8). Therefore, it is important that emergency physicians be skilled in recognizing inflicted trauma in young children. It is well known that physicians working in any emergency department (ED) are under the stress of true emergencies and fast-paced management of situations. Thus, in a busy and fast-paced work environment, they may fail to gather detailed information regarding the history of disease conditions due to abbreviated and directed history taking and physical examination (9). Retrospective chart reviews have indicated uncertainty in determining the cause of a significant number of fractures occurring in young children presenting to the ED (9–13). If a reviewed chart does not provide adequate information to make a conclusion, then the physicians responsible for the care of that child might have been remiss in their need to rule out inflicted trauma. In doing so, an inflicted injury may be managed without a report, thereby placing child and possibly his or her siblings in jeopardy for further injury.

A retrospective chart review was performed to determine whether physicians were sufficiently examining the circumstances surrounding the cause of fractures in young children aged 3 years and younger presenting to Columbus Children's Hospital (Columbus, Ohio). It was hypothesized that 1) there would be a significant number of charts with inadequate information to clarify the cause of fracture(s), and 2) a lack of information would make it impossible to confidently rule out inflicted trauma. Factors influencing physicians' propensity to appropriately report suspected abuse in their patients were also studied.

METHODS

The charts of 653 patients younger than 3 years diagnosed with a fracture in the ED and orthopedic clinic in Columbus Children's Hospital between January 1, 1995, and December 31, 1998, were reviewed. Columbus Children's Hospital is an urban tertiary teaching institution with 66,538 admissions, of which 45 to 48% (average, 46%) were children younger than 3 years during the 1993 to 1998 period. The number of ED and orthopedic clinic visits in that period was 55,611 and 4,792, respectively, of which 40 to 43% (average, 41%) and 22 to 24% (average, 23%) were patients younger than 3 years, respectively.

Charts were reviewed by two of the authors (R.O. and K.B.) without being blinded since there were many notations of report to child protective services throughout the chart, excluding any possibility of blinded review. Information was transferred from the charts onto a data sheet with three main sections developed by one of the authors (C.J.) from a previous study. Information available anywhere on the chart for that admission, including triage notes, ED ledgers, physician progress notes, consultation notes, nurse's notes, and social work notes, was collected.

Section one included patient demographics such as age, race, gender, whether the child was admitted, and fracture characteristics, such as name of fractured bone, location of fracture on the bone, and type and age of fracture. Fracture types included greenstick (unicortical), longitudinal, transverse, oblique, spiral, torus, impacted, comminuted, and bowing. The skull fractures were classified as linear, diastatic, or depressed. Long bone fracture location was classified as physeal, metaphyseal, or diaphyseal (3, 14).

Clarification of the nature of the injury was determined by nine questions (Table 1) in section two on a three-point scale. The scale was as follows: score of 3, complete information when all of the details regarding that item were documented in the chart; score of 2, inadequate information; and score of 1, no information. For instance, regarding how the injury occurred, if there was a notation of "fell from a chair" without any details, it would be considered "incomplete information." If there was a notation of "fell while running after tripping over the edge of carpet onto left leg, leg got stuck under body," it would be considered "complete information." Regarding when the injury occurred, documentation of only a date was considered "incomplete"; documentation of the date and time was considered "complete information." Interobserver agreement was tested and was judged to be high based on the κ value.

Based on the information gathered from these questions, the accuracy in ruling out and in reporting inflicted injury was evaluated by five questions in section three of the data sheet. The first three independent questions in this section were

- Was adequate history provided for the fracture?
- Was injury description adequate?
- Was documentation of history and injury sufficient to rule out child abuse?

TABLE 1
Questions asked to obtain information on injury dynamics

What caused the injury?
How did it occur?
When did it occur?
Where did it occur?
Was a witness present?
Were other injuries noted?
Was a previous injury noted?
Was the past record reviewed?
Was the injury consistent with the development of the child?

The answers to these questions were evaluated on a five-point scale: 1) absolutely yes (score of 5); 2) yes, with some negative reservations (score of 4); 3) indeterminate (score of 3); 4) no, with some positive reservations (score of 2); 5) absolutely no (score of 1).

Based on the scoring of the first three items in this section, the fourth item (Should suspected abuse have been reported?) was evaluated on the same five-point scale. This scoring and classification of patients regarding suspicion of child abuse when reviewing the charts were based on the following criteria:

- Not abused: 1) reasonable history of cause, 2) appropriate timing to seek medical attention, 3) clinical findings consistent with history and developmental level of the child
- Abuse suspected: 1) unreasonable/no history of cause, 2) inappropriate delay to seek medical attention, 3) additional trauma findings inconsistent with history, 4) history inconsistent with child's developmental level
- Abused: 1) same as abuse suspected plus 2) previous known abuse, 3) admission of abuse by the perpetrator, 4) fractures at various stages of healing without reasonable explanation, 5) multiple acute fractures inconsistent with history, 6) presence of classic child abuse injuries

The last question in this section provides information on whether the patient was actually reported for suspected abuse during the initial evaluation. Based on these last two items, four groups from the entire group were anticipated to emerge:

Group 1: Agreed accidental trauma group, which consisted of patients for whom inflicted abuse was not reported and we agreed with that decision

Group 2: Agreed inflicted trauma group, which consisted of patients for whom inflicted abuse was reported and we agreed with that decision

Group 3: Possible missed inflicted trauma group, which consisted of patients for whom inflicted abuse was not reported but we believed that it should have been reported based on information available or missing in the charts

Group 4: Possible missed accidental group, which consisted of patients for whom inflicted trauma was reported but we did not believe that reporting was necessary based on information documented in the charts

Hypotheses for this study were as follows:

1. There would be a significant number of charts with inadequate information to clarify the cause of fracture(s).
2. A lack of information would make it impossible to confidently rule out inflicted trauma.
3. Factors such as young age, admission, multiple fractures, and specialty of the physician (pediatrics) would influence physicians' propensity to appropriately report suspected abuse.

Demographic information for groups 2 and 3 in terms of age, gender, race, number of fractures, fractured bones, physician subspecialty, and admission need was compared by Fisher exact test using the InStat 3.05 statistical analysis program from GraphPad Software (San Diego, CA).

RESULTS

The charts of 653 children were reviewed in the study. Of these patients, 120 (18%) only were seen in the orthopedic clinic, and 533 (82%) had pediatricians involved either during the initial assessment or through admission to pediatric wards. The average pa-

tient age was 18.2 ± 9.2 months (mean ± SD; range, 5 weeks to 3 years). Of the patients, 327 were girls (50%), and 326 were boys (50%). Observed race was documented in 87% of the charts. Children observed to be white, African-American, and Hispanic made up 63%, 21%, and 2% of the study group, respectively (Table 2). During the study time period, the racial distribution of the population in Columbus, Ohio, was 78%, 18%, and 2%, respectively, for the aforementioned races.

The anatomic location of the fracture was documented in 216 (33%) charts for the first fracture bringing the child to medical attention (diaphysis in 103 and metaphysis in 113). For this first fracture, 233 (36%) charts contained documentation of the type of fracture (transverse in 125, spiral in 57, greenstick in 35, and torus in 16). Age of the first fracture was documented for 182 patients (28%; 176 acute, three healing, and three healed).

Of the entire group, 141 patients (22%) had multiple fractures. In addition, 31 patients (5%) had three fractures, and 14 had (2%) four fractures. Of 141 patients with two fractures, location was noted in 40 (28%; 16 diaphyseal and 24 metaphyseal). Type of fracture was documented in 45 (32%; transverse in 36, spiral in four, and torus in five); age of the fracture was noted in 37 (26%; 29 acute, two healing, and six healed). In 31 patients with three fractures, four were noted to have metaphyseal fractures, two were noted to have diaphyseal fractures, and fracture type was documented in five (16%; transverse in three and spiral in two). Age of the fracture was noted for eight (26%; four acute, two healing, and two healed). Fourteen patients had four fractures with no notation of location or type. Age of the fracture was noted for five (36%; two acute, one healing, and two healed; Table 3).

Of the nine areas that were thought to be absolutely necessary in determining the cause of a fracture, information on four was found to be significantly lacking. These missing information categories included witness presence, review of past medical record, injury description, and whether the injury was consistent with the development of the child. Documentation was lacking 14 to 93% of the time depending on the information category (Table 4).

Adequacy of information to rule out inflicted fractures was assessed by the questions in section 2 of the data sheet and is depicted in Table 5. Thus, 39% (indeterminate, probably inadequate, and absolutely inadequate categories) of the charts contained insufficient information to confidently rule out inflicted fracture.

By comparing the available information in the charts with criteria to rule out inflicted fracture, four groups of patients emerged, as shown in Table 6. Of the entire group, the cause of injury was assessed to be accidental in 413 patients (63%), inflicted in 85 pa-

TABLE 3
Number of fractures and documented information for the characteristics of fractures

Fracture	Location		Type		Age	
	N	%	n	%	n	%
Primary (*n* = 653)	216	33	16	2	182	28
Second (*n* = 141)	40	28	5	4	37	26
Third (*n* = 31)	6	19	0	0	8	26
Fourth (*n* = 14)	0	0	0	0	5	36

tients (13%), possible missed inflicted in 151 patients (23%), and possible missed accidental in four patients (<1%).

Of the 151 possible missed inflicted fracture charts, 100 (66%) showed significant lack of historical or injury-descriptive information. In 20 (13%), there were fractures considered to be diagnostic of or highly likely to be due to inflicted injury. In four patients (2%), developmental stage relative to injury was inconsistent. In 16 (11%), multiple fractures at different stages of healing were noted. In 11 (7%) patients, the history was not consistent with the type or extent of injury. Thus, in 23% of the charts, there was concern regarding the need to file a report for inflicted trauma, and the responsible physicians did not do this at the time of initial assessment and management.

Groups 2 and 3 were compared in terms of patient age, gender, race, number of fractures, admission, and the specialty of the physician care provider using Fisher exact test. Gender ($P = 0.077$, OR = 0.5939) and racial ($P = 0.886$, OR = 1.069) distributions were similar between groups. Age was highly significant: the patients for whom suspected abuse was more likely to be appropriately reported tended to be younger ($P < 0.0001$, OR = 5.615). Of group 2, 66% were younger than 12 months, whereas of group 3, 22% were in this age group. Admission was another highly significant variable ($P < 0.001$, OR = 18.198). Of group 2, 58% were admitted to the hospital, whereas of group 3, 16% were admitted. Of the admitted patients, suspected abuse was reported appropriately in 37%, whereas of the nonadmitted patients, suspected abuse was reported appropriately in 7% ($P < 0.001$). Number of fractures affected appropriate reporting as well. Inflicted fracture was more likely to be accurately reported for patients with more than one fracture on presentation ($P < 0.001$, OR = 3.367). Presence of other injuries also significantly influenced reporting accuracy. Suspected abuse was most likely to have been reported accurately for patients whose charts contained documentation of other injuries ($P < 0.0001$, OR = 7.882). The specialty of the care provider was also a predictor of accurate reporting of inflicted trauma. Of the patients seen only by orthopedic physicians, 54% were in the agreed accidental group, 8% were in the agreed inflicted group, and 37% were in the missed inflicted group. The corresponding figures when pediatricians were involved were 66%, 14%, and 19%, respectively. Pediatricians seemed to be more likely to accurately rule out inflicted fractures compared with orthopedic physicians ($P = 0.0004$, OR = 3.6).

DISCUSSION

In this study, we found that 39% of the charts contained inadequate information to confidently determine the cause of the fractures. A thorough history is essential and most reliable for a complete evaluation of possible child abuse. Only if all of the necessary elements of the history have been obtained will it be possible to as-

TABLE 2
Demographics of the study population

Variable	n	%
Gender		
Male	326	50
Female	327	50
Age, mean ± SD, mo	18.2 ± 9.2	
0–6 mo	91	14
6–12 mo	101	15
12–24 mo	324	50
24–36 mo	137	21
Race		
White	409	63
African-American	139	21
Hispanic	14	2
Other	4	1
Not documented	87	13

TABLE 4
Completeness of information in the charts based on the database used (total N = 653)

Inquiry	Complete		Incomplete		No information	
	N	%	N	%	N	%
What caused the injury?	516	79	46	7	91	14
How did it occur?	182	28	282	43	189	29
When did it occur?	288	44	103	16	262	40
Where did it occur?	174	27	119	18	360	55
Was a witness present?	111	17	32	5	510	78
Were other injuries noted?	206	31	56	9	391	60
Was previous injury noted?	60	9	101	16	492	75
Was past record reviewed?	71	11	37	6	545	84
Development level assessment?	31	5	12	2	610	93

sess the consistency of the story provided with the extent and mechanism of injury and the development of the child. These elements are

- What caused the injury
- How this incident happened in relevant detail to assess whether the mechanism of injury is consistent with the extent of injury
- When the incident occurred to assess whether inadvertent delay in seeking help has taken place
- Where the incident occurred
- Witness presence
- Previous unexplained injuries
- Developmental level of the child

The results of this study proved our hypotheses to be true for the management of fractures in children younger than 3 years. Physicians in ED or orthopedic clinic settings do not document and/or assess accurately the data that they gather in order to appropriately rule out inflicted fractures.

In this study, the percentage of cases in which we could not develop a clear understanding as to the cause of the fracture made up 16% of the charts. In several retrospective studies of fractures in children, researchers reported a category of unknown, ranging from 4 to 14% (9, 10, 15–18). Thus, documentation is clearly a problem in the charts of children with fractures in this age group.

The injury mechanism was documented completely in 79% of the charts in this study. Johnson et al. (9), Boyce et al. (10), Socolar et al. (11), Limbos and Berkowitz (12), and Christopher et al. (19) are some of the researchers who looked into the quality of physicians' management of injuries. Their study results are compared with ours in Table 7. The lower rates of documentation in our study may be a function of the fact that one fifth of the patients in our study were assessed only by orthopedic physicians, who provided appropriate documentation less frequently.

Regarding the data on complete physical examination, Johnson et al. (9) reported that the most significant missing information was a description of the injuries. Limbos and Berkowitz (12) reported that a description of the injuries and genital examination were the most important examination parameters missing in the charts. Thus, it is clear that whether fractures, other injuries, or sexual abuse are being assessed, physicians are not adequately taking a history, performing a physical examination, or documenting their actions.

As stated by several authors, no fracture of any bone is "pathognomonic" of abuse. To arrive at the correct diagnosis, the entire history, physical examination, and laboratory information should be considered thoroughly in each case (18). A lack of historical information in the charts reviewed is alarming.

The completeness and accuracy of chart documentation may not reflect the full extent of information sought by the medical staff. Medical staff may not believe that it is necessary to document normal findings. If pertinent information is not documented in the chart, one may conclude that it may not have been considered during acute assessment.

Twenty-three percent of the charts prompted concern regarding inflicted fracture. However, with the design of this study, we cannot claim for certain that these injuries were inflicted. There may have been historical information gathered by the physicians at the initial encounter with the patient that helped them rule out inflicted fracture. However, due to failure to document key history in the chart, an observer would be led to believe that there was an inconsistency between the injury and the history or that there was no explanation for the injury. Boyce et al. (10) suspected abuse in 6% of the cases in their study. Johnson et al. (9) had concerns about

TABLE 5
Adequacy of information to rule out inflicted fractures

Degree of adequacy	n	%
Absolutely adequate	131	20
Probably adequate	267	41
Indeterminate	104	16
Probably inadequate	73	11
Absolutely inadequate	78	12

TABLE 6
Patient groups regarding inflicted trauma status by researchers and primary physicians

Patient group	n	%
Group 1: Agreed accidental fracture group*	413	63
Group 2: Agreed inflicted fracture group	85	13
Group 3: Possible missed inflicted fracture group†	151	23
Group 4: Possible missed accidental fracture group	4	<1

*Patients who were not reported for suspected abuse by primary physicians and the researchers agreed on that decision.

†Patients who were not reported but researchers believed that cases should have been reported as inflicted fracture.

TABLE 7
Study findings compared with those of similar studies

	Current study N = 653	Christopher et al. (19) N = 669	Johnson et al. (9) N = 333	Boyce et al. (10) N = 642	Limbos and Berkowitz (12) N = 44	Socolar et al. (11) N = 552
Injury mechanics*	79	86	92	95	98	73
When	44	66	79	93	65	48
Where	27	48	7	79	NI	41
Witness presence	17	16	5	28	19	NI
Developmental level	5	NI	0	NI	0	NI
Previous injuries	9	10	8	11	50	NI
Old chart review	11	NI	0	NI	NI	NI
Complete examination	31	22	33	38	50	50

*Figures show percentage of completeness of documentation of each parameter.

NI = no information.

whether the injury occurred the way the caretakers described it in 13% of the cases studied, and they identified inconsistency with the development of the child in 1% of the charts. The higher percentage of cases in which we were concerned about abuse in our study may be due to the inclusion of 120 charts of children (18%) managed solely by orthopedic physicians. Orthopedic physicians' comments on the charts often included simply "(0–3) year-old (male/female) with (toddler/greenstick, etc.) fracture." Children in this group may have had fractures that were specific indicators of abuse or multiple fractures with no explanation. Children younger than 12 months comprised 25% (n = 192) of the entire group. Forty-two of these patients were managed only by orthopedic physicians, and 20 (48%) had charts that raised concern for missed inflicted fracture. In this same age group, 149 patients were managed by pediatricians, and 36 (24%) had charts that raised concern for missed inflicted fracture.

Several authors have reported that abusive fractures are seen more frequently in younger children compared with accidental fractures (6, 20). This increased suspicion may have prompted appropriate reporting in younger children. The younger the patient, the lower the chance of being in the missed inflicted fracture group. The likelihood of an inflicted injury being reported appropriately was five times higher when the child was younger than 12 months. Zellman (21) reported that patient age had an impact on prompting physicians' reporting intentions in cases of suspected abuse.

In a study conducted by Morris et al. (22), the compatibility of the history with the injury, the severity of the injury, and the presence of other injuries prompted 53 to 85% of physicians to report the injury as suspected abuse. In this study, injury severity might correspond to the need for admission. Admission, multiple fractures, and the presence of other injuries did prompt physicians to report suspicious fractures ($P < 0.001$, $P < 0.001$, and $P < 0.0001$, respectively). Warner-Rogers et al. (23) reported a strong correlation between the severity of the patient's injuries and appropriate reporting of suspected abuse. Documentation of the compatibility of the injury with the provided history is very important, especially when the injury is highly specific for abuse, such as rib fractures, metaphyseal chip fractures, or vertebral/sternal fractures. In this study, 17 patients were noted to have metaphyseal fractures with no reasonable explanation. A statement that the injury was or was not compatible with the history was not documented in any chart in this study.

Zellman (21) reported that previous abuse, severe abuse, and family poverty enhanced reporting. In the charts we reviewed, there were no notations of previous abuse. The socioeconomic

level of the patients was not documented in this study, as the pay status noted on the registration sheet might not accurately reflect the socioeconomic level.

Physician specialty (pediatrics vs orthopedics) had a significant impact on reporting practice ($P = 0.0004$). In a study conducted in Israel, Offer-Shechter et al. (24) found that medical discipline has a significant effect on knowledge of abuse and neglect but not on reporting. Saulsbury and Campbell (25), on the other hand, did not find any correlation between the specialty of the physician and reporting attitudes. However, they reported that the type of maltreatment did influence reporting attitudes, with suspected neglect and emotional abuse being reported almost half as frequently as physical and sexual abuse.

In order to differentiate between inflicted injuries and fractures and accidental ones, physicians must have a high index of suspicion and good diagnostic skills. They should be knowledgeable about the patterns of child growth and development and common inflicted and noninflicted injuries in children (22, 23, 26–28). Differentiation between inflicted and accidental injury is rarely without difficulty. Sometimes physicians may make unnecessary reports. This may have happened in four patients in this series. This is a very important issue since unwarranted reporting may be quite burdensome on families and children. Physicians must avoid both over- and underreporting. In order to make an appropriate reporting decision, they must gather all of the necessary information, including a thorough history regarding the following questions: What caused the injury? How did it occur? When and where did it occur? Who witnessed the event? Furthermore, all of this information needs to be documented for good clinical practice. Delays in seeking medical help; parental behaviors in the ED; complete physical examination findings, including both normal and abnormal ones; and records of previous injuries or involvement with child protective services in the past should be sought and recorded in the charts (3, 18). Each injury assessment should end with the following statement: "the injury is/is not compatible with the history of the injury and/or the child's development" (9). If not compatible, a suspected abuse form must be filed.

The shortcoming of this retrospective study was that it could not be designed to identify the "true" missed inflicted fractures. Because of this limiting factor, the goal of our study was to find out how complete the documentation was in the charts. Thus, we do not know if the concerns about possible missed inflicted fractures are actual or not. It might have been that the physician examining a child with a likely accidental fracture simply failed to document this conclusion in the chart. This kind of patient would fall into the

"inadequate documentation" category but not necessarily the "possible missed inflicted fracture" category. However, there were other charts in which there was sufficient information to prompt concern regarding inflicted trauma (such as young age, specific fracture type, or multiple injuries) but not enough information to satisfy our concerns. These were patients that we included in the "possible missed inflicted fracture" category. However, we cannot claim that these were truly missed cases of inflicted fractures. It might have been that the physicians examining these children shared our concerns regarding the injury type, patient age, and so forth and asked the appropriate questions and ruled out inflicted injury but simply did not document it in the chart. A prospective study could possibly clarify this issue.

Several studies have shown that educational programs and protocols for better assessment of such injuries are not sufficient to improve ED management of fractures and injuries (9, 11–13, 19, 24, 29, 30). The use of a checklist to ensure that all of the necessary information is gathered in the assessment of an injury should improve documentation. The management of abuse/injury cases should be improved by periodic chart audit. Finally, computer-generated, complaint-specific, prompted ED ledgers may also be used to increase awareness. Protocols should be developed in children's hospitals to involve pediatricians in the management of every child with an injury.

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