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ORIGINAL RESEARCH

Pediatric fractures – an educational needs assessment of Canadian pediatric emergency medicine residents

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Objectives: To determine the gaps in knowledge of Canadian pediatric emergency medicine residents with regards to acute fracture identification and management. Due to their predominantly medical prior training, fractures may be an area of weakness requiring a specific curriculum to meet their needs.

Methods: A questionnaire was developed examining comfort level and performance on knowledge based questions of trainees in the following areas: interpreting musculoskeletal X-rays; independently managing pediatric fractures, physical examination techniques, applied knowledge of fracture management, and normal development of the bony anatomy. Using modified Dillman technique the instrument was distributed to pediatric emergency medicine residents at seven Canadian sites.

Results: Out of 43 potential respondents, 22 (51%) responded. Of respondents, mean comfort with X-ray interpretation was 69 (62–76 95% confidence interval [CI]) while mean comfort with fracture management was only 53 (45–63 95% CI); mean comfort with physical exam of shoulder 60 (53–68 95% CI) and knee 69 (62–76 95% CI) was low. Less than half of respondents (47%; 95% CI 26%–69%) could accurately identify normal wrist development, correctly manage a supracondylar fracture (39%; 95% CI 20%–61%), or identify a medial epicondyle fracture (44%; 95% CI 24%–66%). Comfort with neurovascular status of the upper (mean 82; 95% CI 75–89) and lower limb (mean 81; 95% CI 74–87) was high.

Interpretation: There are significant gaps in knowledge of physical exam techniques, fracture identification and management among pediatric emergency medicine trainees. A change in our current teaching methods is required to meet this need.

Keywords: pediatric, fractures, education, radiologic interpretation

Objectives

Injuries and poisonings are the most common reasons for presentation to pediatric emergency departments with over 7 million visits per year in the US.[1] A large proportion of these presentations are for musculoskeletal injuries, including fractures. It is therefore important that pediatric emergency medicine (PEM) physicians have adequate skills for the diagnosis and management of fractures. The interpretation of X-ray radiography, knowledge of the normal development of the bony anatomy, and specific physical exam techniques are all important components in the recognition of, and the assessment of severity of, orthopedic injuries. Management requires specific knowledge of the healing and remodeling capabilities of each commonly fractured site in addition to practical skills of closed reduction and casting.

In the Canadian system PEM trainees predominantly come from medical based general pediatrics residency programs. The trainees have strong general medical

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knowledge from 3 to 4 years of training. However, these learners, unlike their general emergency colleagues who have broad exposure to trauma, have relatively little experience in treating injuries. Core training in pediatrics in Canada requires 1–4 months of emergency medicine and there is no required training in orthopedics.[2] There is no current knowledge about the limitations and gaps in knowledge of PEM trainees with regards to fracture recognition and management. The development of an appropriate curriculum begins with a needs assessment of the learners.[3] Therefore the overall objective of this study was to assess the current and recently graduated PEM trainees' comfort level with fracture management and their performance on specific case based questions. The results of this survey are intended to inform the development of a case based curriculum in pediatric fracture management.

Methods

Participants

This study sought to determine gaps in knowledge regarding fracture identification and management among PEM trainees in Canadian residency programs. The survey was distributed to 43 current and recently graduated, within the past 1 year, PEM residents at seven sites (Dalhousie University, University of Ottawa, Université de Montreal, University of Toronto, University of Alberta, University of Calgary, and University of British Columbia). Contact information was obtained from the program directors at each site. Prior to distribution of the questionnaire the study was approved by the University of Alberta-Human Research Ethics Board 2 of the principal investigator.

Instrument development

A panel of PEM experts at the University of Alberta had input into the purpose, length, format, and content of the tool. It was assessed by general pediatric residents for understandability and time to complete. The areas of interest identified by the expert panel were a) comfort of trainees in interpreting MSK X-rays; b) comfort in independently managing pediatric fractures (ie, only involving orthopedics when a procedure outside of their scope of practice was required); c) comfort in MSK physical examination techniques; d) applied knowledge of fracture management when applied to cases and e-knowledge of normal development of the bony anatomy.

A series of questions regarding comfort interpreting radiography of various body parts, managing particular fractures, and performing physical exam techniques were developed, with scoring on a 0–100 visual analog scale. Comfort is a useful marker in the development of curricula for adult learners who are generally adept at identifying areas of weakness in knowledge.[3] The visual analog scale was chosen to give respondents a broad range of possible responses. It has not been specifically validated for use with comfort, but has been validated and used in many other contexts including pain, anxiety, and comfort.[4–6] In addition a series of knowledge questions related to X-ray interpretation, fracture management, implementation of the Ottawa Ankle rule, and timing of ossification centers were included to correlate the comfort of the learners with their actual knowledge and ability to apply that knowledge to specific patient scenarios. The Orthopedics Survey is available online.

Data collection procedure

Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of Alberta.[7] REDCap is a secure, web-based application designed to support data capture for research studies, providing: an intuitive interface for validated data entry; audit trails for tracking data manipulation and export procedures; automated export procedures for seamless data downloads to common statistical packages. A modified Dillman's tailored design method[8] was used with three reminder emails sent a week apart to maximize the response rate. All responses were kept confidential and only aggregate data are reported.

Analysis

Data analysis was performed with REDCap and Microsoft Excel 2007. Descriptive statistics (means, standard deviations, and percentages) were used to describe the respondents' training, their comfort with fracture identification and management as well as their knowledge level based on practical questions. Confidence intervals for proportions were calculated via the Wilson score method.

Results

Characteristics of respondents

A total of 22 PEM trainees responded to the questionnaire. All of the respondents provided demographic information and identified their highest level of training as PEM year 1 (n=7), PEM year 2 (n=10) and completed training within past 1 year (n=5). The primary training program was predominantly pediatrics (n=20) with the remainder from emergency medicine (n=2). The majority of respondents (59%) work at a site where closed reductions are performed

Table 1 General data

	Number (%)
Year of PEM training 1	7 (31.8%)
Year of PEM training 2	10 (45.5%)
Completed training in past 1 year	5 (22.7%)
Primary training-pediatrics	20 (90.9%)
Primary training emergency medicine	2 (9.1%)
Closed reductions-PEM	9 (40.9%)
Closed reduction-orthopedics	13 (59.1%)

Abbreviation: PEM, pediatric emergency medicine.

mostly by orthopedic surgeons. There were respondents from all participating sites (Table 1).

Comfort with X-ray interpretation and fracture management

Respondents were moderately comfortable with X-ray interpretation in the setting of orthopedic injuries (69; 95% confidence interval [CI] 62–76) and this comfort increased with years of PEM training. Although it is not statistically significant there does appear to be a lower comfort level with radiography of the foot (54; 95% CI 44–64). There was a lower level of comfort with independent fracture management (53; 95% CI 45–63), when defined as only consulting with orthopedics when the patient required a procedure outside of the respondent's scope of practice. Again this comfort improved with years of training. Results summarized in Table 2.

Physical examination for neurovascular status of the upper and lower limbs appears to be an area of high comfort (upper 82; 95% CI 75–89: lower 81; 95% CI 74–87). There were lower levels of confidence regarding knee (69; 95% CI 62–76) and shoulder (60; 95% CI 53–68) examinations.

Respondents felt similarly about fracture involving the radius/ulna, tibia/fibula, and ankle. Results summarized in Table 3. For elbow fractures similar levels of comfort were noted for the commonly clinically seen supracondylar fractures (60; 95% CI 50–71), however there was less comfort reported with rarer elbow injuries, such as condylar fractures (52; 95% CI 43–60).

Identification of the timing of ossification centers was generally well done with the exception of identification of the ossification of the capitate (47% correct: 95% CI 26%–69%), perhaps indicating less comfort with wrist development. Residents were able to accurately apply the Ottawa Ankle rule as it applies to children (83% correct: 95% CI 60%–94%). Cases relating to forearm and ankle fractures had high levels of correct responses. Interestingly residents performed poorly on management of supracondylar fractures (39% correct: 95% CI 20%–61%) although all of them appropriately identified the fracture. The medial epicondyle case was challenging with respect

Table 2 Comfort with X-ray interpretation

Comfort with interpretation of X-rays by region	Mean (0–100 scale) (95% CI)
MSK injury – general	69.1 (62–76)
General by year	Year 1 – 54 (41–67)
	Year 2 – 73 (63–73)
	Complete – 78.4 (72–85)
Foot	53 (44–64)
Hand	64 (56–72)
Knee	67 (60–75)
Elbow	73.3 (64–83)

Abbreviations: CI, confidence interval; MSK, musculoskeletal.

Table 3 Independent management and physical examination

Comfort with physical exam and fracture management	Mean (0–100 scale) (95% CI)
Pediatric fractures – general	53 (45–63)
General by year	Year 1 – 35 (25–45)
	Year 2 – 59.8 (49–70)
	Complete – 70.0 (51–89)
Supracondylar	60 (50–71)
Elbow condylar/epicondylar	52 (43–60)
Radius and ulna	66.8 (58–76)
Tibia and fibula	61 (51–71)
Ankle	59 (51–67)
Examination of shoulder	60 (53–68)
Examination of knee	69 (62–76)
Neurovascular examination – upper limb	82 (75–89)
Neurovascular examination – lower limb	81 (74–87)

Abbreviation: CI, confidence interval.

Table 4 Knowledge and application

Question/case	Correctly identify injury or answer question (95% CI)	Appropriate management or knowledge of acceptable angulation/displacement (95% CI)
Supracondylar fracture	100% (87–100)	39% (20–61)
Medial epicondyle fracture	44% (24–66)	56% (34–75)
Radius/ulna fracture		89% (67–97)
Triplane fracture	89% (67–97)	89% (67–97)
Radial torus fracture		74% (55–91)
ASIS avulsion	72% (49–87)	33% (16–56)
Ottawa Ankle rule	83% (60–94)	
Capitate-ossification	47% (26–69)	
Scaphoid-ossification	71% (47–87)	
Radial head-ossification	71% (47–87)	
Olecranon-ossification	82% (59–94)	

Abbreviations: CI, confidence interval; ASIS, anterior superior iliac spine.

to both in identification (44% correct: 95% CI 24%–66%) and management (56% correct 95% CI 34%–75%). Results summarized in Table 4.

Discussion

This is the first study to examine PEM trainees' knowledge and comfort with fracture identification and management. It was broadly distributed to gain knowledge from multiple centers in order to identify broader themes rather than local specific training gaps. It shows that comfort with interpretation of radiography is reasonably good. Although, not as high as might be expected for such a common presentation. Furthermore, imaging of the foot appears to be particularly problematic. This complex structure, with multiple overlapping bones on imaging, is also not commonly fractured, giving trainees little clinical experience; a combination of factors that leaves trainees with concerns about interpretation. With such complex and less common clinical presentations, directed teaching of skills is important and should be an area of increased focus for PEM programs.

Management comfort was only moderate to low in general. There was graduated improvement over years of training, by 2nd year the comfort had increased from 1st year (35 95% CI 25–45) but remained relatively low (59 95% CI 49–70). By completion of training this comfort had moderately improved (70 95% CI 51–89). While this improvement is encouraging the final levels of comfort are low for such common presenting problems. Elbow injuries, beyond the most common supracondylar fractures, seem to pose a particular problem for learners.

Physical examination of the shoulder and knee was also found to be an area of significant discomfort indicating a need for improvement in teaching of even these basic skills. Physical examination of neurovascular status on the other hand was a perceived area of strength. This is interesting considering that recent literature suggests that neurovascular exams are poorly performed for children in emergency departments.[9] Such a disconnect between trainee performance and documented clinical practice may indicate that the learners are unaware of real deficiencies as their teachers are not role modeling the skill. Knowledge of ossification was generally strong with the exception of the ossification of the capitates, perhaps indicating a lack of teaching around wrist development.

The results of the case based questions indicate a particular difficulty with injuries of the elbow, which correlates well with the respondents' reported levels of discomfort with this region. Supracondylar fracture identification was excellent, but the appropriate subsequent management was an area of some uncertainty, with only 40% of respondents being able to identify the appropriate management for the case provided. Condylar fractures of the elbow posed problems with both identification and management with less than half being able to accurately identify which part of the humerus was injured, and only just over half identifying the correct management plan. These results indicate that the complex elbow joint poses a particular problem for learners, and their reported discomfort with the elbow shows that they are aware of this deficiency.

Limitations

Any survey study introduces a risk of selection bias; those who respond to the survey may have more interest or knowledge in subject matter. Responses to management questions may be altered by local practice by orthopedics which may or may not be consistent with textbook interpretation. The results are also limited by the small number of PEM residents in Canada. Within the past 3 years at seven sites only 43 trainees were identified. The survey was limited to current and recently graduated trainees so their responses were indicative of current training. However, their small number certainly limits the generalizability of the results reported.

Conclusion

While comfort in identification and management did improve over years of training there was still only moderate comfort with management of fractures. The interpretation of feet radiography was a particular area of concern. In terms of comfort and performance on knowledge questions the complex nature of the elbow joint poses significant issues for learners to adequately assess and treat injuries to this joint. The curriculum developed from this survey must focus on the areas of identified weakness around management in general and specifically the elbow joint.

Disclosure

The author has no conflicts of interest to disclose. This was an unfunded study. Free access to the REDCap database was obtained through the University of Alberta, Women and Child Health Research Institute.

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