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Defining No Pain, Mild, Moderate, and Severe Pain based on the Faces Pain Scale – Revised and Color Analog Scale in Children with Acute Pain

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INTRODUCTION

Self-report is widely recommended as the primary source for assessment of pain intensity in children over 3 or 4 years of age ¹. Most children can provide meaningful reports about how much pain they are experiencing when developmentally appropriate tools are used. The Faces Pain Scale – Revised (FPS-R) and Color Analog Scale (CAS) are two commonly used self-report measures of pain that have been studied in both clinical and research settings, including the pediatric emergency department (PED) ^{1–5}.

The interpretation of reported scores for the Faces Pain Scale – Revised (FPS-R), however, has not been well defined in qualitative terms that are meaningful to the child. Being able to classify a child's reported pain score as mild, moderate and severe is useful for clinical practice, as well as for research, as these categories of pain intensity often form the basis for treatment decisions.

In addition, a child's perception and reporting of pain may be influenced by clinically-pertinent characteristics. Previous studies have shown that age, sex, and ethnicity are related to a person's ability to describe pain and can also influence their perception and sensitivity to pain ^{6–12}. Children with varying characteristics may potentially interpret a score on a pain scale to be of differing intensity, which could impact clinical management. It has not been shown whether pain scale scores associated with categories of pain intensity vary based on patient characteristics when using the FPS-R or the CAS.

We aimed to define the ranges of FPS-R and CAS scores associated with no pain, mild, moderate, and severe pain in children presenting to the emergency department, and to identify any differences in the scores associated with each category of pain intensity based on age, sex and ethnicity.

MATERIALS AND METHODS

Participants

We conducted a prospective, observational study in two urban pediatric emergency departments with a combined annual census of approximately 110,000 visits. This investigation was one component of a validation study of the FPS-R and CAS¹³. English- and Spanish-speaking children between the ages of 4 to 17 years of age, inclusive, were eligible. Children with any of the following were excluded: clinical instability or illness necessitating admission to the intensive care unit; developmental delay or neurologic impairment; altered mental status; an underlying chronic pain condition, such as sickle cell disease; or a medical history of multiple painful experiences, such as malignancies. We enrolled children with and without painful conditions as identified by the nurse at triage, and confirmed by asking the children themselves if they had “any pain” or “any hurt” immediately prior to the initial assessment. The institutional review boards of both sites approved this study with written informed consent.

Measures

The FPS-R consists of six faces, each one representing an increasing degree of pain moving from left to right (Figure 1), scored 0-2-4-6-8-10. Each child was shown the scale and read standard instructions in English or Spanish (both versions from www.iasp-pain.org/FPSR).

The CAS is a two-sided plastic instrument that consists of a wedge-shaped color-graded figure (white bottom-end to dark red top-end) on one side, a numerical scale on the other, and a moveable slider (Figure 1). The child was shown the wedge-shaped figure with the slider positioned in the middle, and read a standard script: “Move the slider to the place that shows how much pain you have. This end means you have no pain [*slider moved to the bottom*], this end means you have the worst pain [*slider moved to top*].” The slider was moved back to the middle of the scale before the child used the scale. After the child finished moving the slider, we recorded the corresponding numerical score from the other side of the instrument (scored from 0 to 10 in 0.25 units).

Procedures

We performed all assessments in the child’s primary language using standardized scripts. Children with painful conditions were first asked to choose a qualitative descriptor of their pain: “A little bit of pain”, “a lot of pain”, or “somewhere in between”. As in prior studies, we used these phrases as proxies for the categories of mild, severe, and moderate pain, respectively^{3, 14}. Children were then asked to indicate their level of pain first on the FPS-R and then on the CAS. For both scripts, the word “hurt” or “pain” was used interchangeably, depending on what seemed most understandable for each child. Children with non-painful

conditions were also asked to indicate their level of pain first on the FPS-R and then on the CAS.

Race and ethnicity of children were either self-identified or provided by the family caregiver. Classifications were based on the National Institute of Health Policy on Reporting Race and Ethnicity Data, which include two ethnic categories (Hispanic or Latino and Not Hispanic or Latino) and five racial categories (American Indian or Alaska Native; Black or African American; Native Hawaiian or Other Pacific Islander; and White) ¹⁵.

Analyses

We used descriptive statistics (mean, SD, median, interquartile range) to summarize the data, including the FPS-R and CAS scores associated with each category of pain intensity. To define the range of pain scores associated with each category of pain intensity, we used a receiver operating characteristic (ROC)-based method ^{16, 17}. We compared each pair of adjacent categories of pain intensity (e.g., no pain and mild pain; mild and moderate pain; moderate and severe pain) to identify a cutpoint that best differentiated between the pair, meaning that we chose the cutpoint that yielded the highest Youden index (sum of sensitivity and specificity) ¹⁸. In order to evaluate the overall performance of each cutpoint, we reported its area under curve (AUC), as well as sensitivity and specificity. Since cutpoints determined in this way suffer from random variability, we used bootstrapping to quantify the variability of these cutpoints and took this into account when comparing groups ¹⁹. The cutpoints identified for each pair of adjacent categories were used to define the range of pain scores associated with each category of pain intensity.

To evaluate for any differences in the range of pain scores associated with each category of pain intensity based on patient characteristics, we determined and compared the cutpoints within subgroups based on age group (younger = 4 to 7 years, older = 8 to 17 years); sex (male and female); and ethnicity (Hispanic and non-Hispanic). Post-hoc exploratory analyses examined and compared the cutpoints within subgroups based on race (African American and White); primary language (English and Spanish); and year of age in younger age group (ages 4, 5, 6, and 7 years old). Other subgroups based on race were not analyzed due to insufficient sample size. All statistical analyses were performed with SPSS (version 20, IBM Corp., Armonk, NY) and R using the ROCR package ²⁰.

RESULTS

From June 2011 to October 2012, a total of 660 children were enrolled; 40 children were removed from analysis because of missing data. The characteristics of the remaining 620 children are presented in Table 1. Figures 2 and 3 display the frequency of each pain score reported for both pain scales. Table 2 displays the mean and median scores for each category of pain intensity. There was considerable overlap between the 95% CI for mean pain scores, and IQRs for median pain scores, associated with “a little bit of pain”, and “somewhere in between” for both the FPS-R and CAS (Table 2, Figure 4).

Tables 3 and 4 present the optimal cutpoints identified for each pair of adjacent categories of pain intensity for the FPS-R and CAS, respectively. Based on these cutpoints and the

specific units of measure for each scale, proposed score ranges representing each category of pain intensity for the FPS-R were: no pain, 0 and 2; mild pain, 4; moderate pain, 6; and severe pain, 8 and 10. For the CAS, the respective score ranges were 0-1, 1.25-2.75, 3-5.75, and 6-10. Figures 5 and 6 display the ROC-curves for the three cutpoints for the FPS-R and CAS, respectively. For the FPS-R, the cutpoints identified for differentiating between no pain and mild pain, and between moderate and severe pain, had good discriminative abilities (AUC 0.87 and 0.84, respectively); for the CAS, the cutpoints for differentiating these categories of pain had similarly good discriminative abilities (AUC 0.81 and 0.85, respectively). However, for both the FPS-R and CAS, the best possible cutpoints identified for differentiating between mild and moderate pain had poor discriminative abilities (AUC 0.59 and 0.64, respectively).

There were no differences between the optimal cutpoints identified for each pair of adjacent categories of pain intensity for both scales within the subgroups based on age, sex, ethnicity, primary language, race, and year of age in younger age group (Supplementary Tables 1 to 12). The discriminative ability of these cutpoints were similar to those described in the overall population (Tables 3 and 4). The one exception was a slightly better discriminative ability of the cutpoint differentiating mild and moderate pain in the group of younger children (AUC 0.71). Some cutpoints showed very wide variability. For example, in Spanish speaking children, all possible cutpoints (i.e. 1 to 10) for differentiating between mild and moderate pain were identified as optimal in some of the bootstrapping samples.

Of the 306 children who said they had no pain, 139 (45.4%) and 170 (55.6%) reported pain scores that were not zero when using the FPS-R and CAS, respectively. When using the FPS-R, 54.6% of children who said they had no pain reported a score of zero and 32% reported a score of two. When using the CAS, 44.4% of children who reported no pain endorsed a pain score of zero and 18.6% reported a non-zero score of 1. When using the FPS-R, 64 (46%) of these 139 patients were in the younger age group, and 75 (54%) were in the older age group. When using the CAS, 86 (50.6%) of these 170 patients were in the younger age group, and 84 (49.4%) were in the older age group. There was no difference between the proportions of children who said they had no pain, but reported non-zero pain scores, in younger and older age groups when using the FPS-R and CAS ($p=0.19$ and 0.83 , respectively).

DISCUSSION

In the present study, we established pain scale scores for children with acute pain that are associated with no pain, mild, moderate, and severe pain for both the FPS-R and CAS. Children who reported no pain did not exclusively report pain scale scores of zero. Pain scores associated with “a little bit of pain” and “somewhere in between” overlapped considerably, and the optimal cutpoint identified for differentiating these two categories was weak. We identified statistically significant, but not clinically meaningful differences based on patient characteristics in means and/or medians of pain scale scores associated with categories of pain. Similarly, we did not identify clinically meaningful differences in optimal cutpoints based on patient characteristics. This suggests that similar ranges of pain scale

scores can be used to define pain intensity amongst the studied subgroups based on age, sex, and ethnicity.

Previous studies of children with acute pain have identified means and medians for the FPS and CAS that are associated with categories of pain intensity but have not explicitly identified the cutpoints that define the range of scores within each category^{3, 14}. The cutpoints we identified for both scales were, in general, not whole numbers. For the FPS-R, the cutpoints we determined allowed us to place each face into a category of pain intensity, such that 0 and 2 = no pain, 4 = mild, 6 = moderate, and 8 and 10 = severe. For the CAS, the cutpoints were compatible with the 0.25 increments of the scale, such that 0-1 = no pain, 1.25-2.75 = mild pain, 3-5.75 = moderate pain, and 6-10 = severe pain.

These suggested pain scores representing each category of pain intensity differ from those conventionally used, which are 0 = no pain, 1-3 = mild, 4-6 = moderate, and 7-10 = severe^{13, 21-25}. To our knowledge, there was no methodological basis to the determination of these prior cutpoints. Rather, they appear to be a distinction made by convention, and the assumption of their validity is reinforced by their ubiquity. The cutpoints we have determined, on the other hand, are based on a methodology that produced results consistent with the mean and median FPS-R and CAS scores associated with each category of pain intensity in this study, as well as that identified for the CAS in prior studies of similar populations^{3, 14}. Scores associated with categories of pain intensity have not been defined in prior studies for the FPS-R. The cutpoints we determined have the advantage of taking into consideration those patients who reported no pain, thereby allowing us to more accurately define the scores differentiating no pain from mild pain. This was important because we found that some scores on the lower end of the pain scale actually better represented no pain (albeit not exclusively), rather than mild pain.

The finding that a large proportion of children with no pain reported scores that were not zero is an important observation that is contrary to convention; namely, that a child with no pain will only report a pain score of zero. This finding is similar to one prior study of the original Faces Pain Scale and CAS, in which the interquartile range of both scales were 0-1 face and 0-1 units, respectively³. In addition, there were children in all subgroups based on age, ethnicity and race who reported non-zero scores when reporting having “no pain”, suggesting that the clinical implications of a non-zero pain score remain the same across these subgroups of patient characteristics. Ultimately, even though the anchor of zero was explained to children to mean “no pain” for both scales, one cannot assume that a child with no pain will only report zero when using either pain scale. Similarly, a reported pain score greater than zero, without further clarification, should not automatically prompt the administration of an analgesic or pain-reducing intervention.

Another difference from convention is our placement of a score of 4 in the category of mild pain for the FPS-R, rather than moderate^{13, 21-25}. The clinical implication of this change would potentially be to reduce the number of children with mild pain from receiving disproportionately-potent analgesics. For the CAS, one difference from convention is our placement of a score of 6 in the category of severe pain, rather than moderate^{13, 21-25}. This would have a different effect on clinical practice, by potentially increasing the number of

children with severe pain who might receive stronger analgesics (e.g. opioids) and mitigate the under treatment of pain. Although these differences from convention are subtle, they could be potentially significant given that clinical practice, such as the choice of analgesic to administer, is often guided not by the pain score itself, but by the category of pain intensity that score is thought to ultimately represent ²⁶.

It is important to note, however, that many children who reported moderate pain had pain scores that were the same as children who reported mild pain. Although our methodology was designed to accurately differentiate children of different pain categories as best possible, the amount of overlap of scores associated with mild and moderate pain should prompt a more thorough evaluation to accurately identify a child's pain intensity when pain scores associated with these categories of pain intensity are reported. Clinical judgment, observation for behaviors consistent with pain, and consideration of the clinical context may be useful adjuncts to determine the best course of management in this situation ²⁷.

In this study, we defined categories of pain intensity by using comparisons of reported pain intensity with a pain scale score. However, given that categories of pain intensity are often used to guide clinical practice with patient-centered outcomes, an alternate approach to defining categories of pain intensity could be to use comparisons of pain intensity with functional goals or needs instead. For example, categories of pain intensity have been defined in adolescents and adults with chronic pain by determining the associated degree of interference that the pain had on functions such as activity, mood, and sleep ^{28, 29}. The impact of pain on activities of daily living may be less applicable in the child experiencing acute pain, but a more contextually appropriate construct could be used instead, such as the child's expressed desire for additional analgesia or the child's comfort-function goal ^{30–35}.

Limitations of our study include the focus solely on acute pain. Our results may not be generalizable to children with chronic pain, as they are known to perceive pain differently ^{36–39}. Second, although similar to prior studies, our use of the qualitative phrases, "a little bit of pain", "somewhere in between", and "a lot of pain" to represent mild, moderate, and severe categories of pain may have introduced imprecision into our results ^{3, 14}. Younger children do not use or understand words such as mild, moderate, or severe, so we used these descriptive phrases instead to accommodate for the lowest expected level of comprehension. Finally, the comparatively small sample size in certain subgroups (e.g. Spanish-speaking children, children within each year of age in the younger age group) may have limited our ability to detect differences in the post-hoc comparisons.

CONCLUSIONS

We have defined a range of scores for the FPS-R and CAS associated with categories of pain intensity in children presenting to the emergency department, with minor but potentially important differences from prior convention (FPS-R: no pain, 0 and 2; mild pain, 4; moderate pain, 6; and severe pain, 8 and 10; CAS: no pain, 0-1; mild pain, 1.25-2.75; moderate pain 3-5.75; and severe pain, 6-10). Children who report no pain do not exclusively report a pain score of zero. Those with mild or moderate pain may report similar scores. Finally, there did not appear to be any clinically meaningful differences in pain

scores associated with each category of pain intensity based on patient characteristics. Future considerations should explore defining pain intensity for children with acute pain based on clinical needs, or comfort-function goals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Left: Faces Pain Scale - Revised (FPS-R). Copyright © 2001, International Association for the Study of Pain. Reproduced with permission from Hicks CL et al., *Pain* 2001;93:176. See www.iasp-pain.org/FPSR. Right: Color Analog Scale (CAS). Reproduced with permission from McGrath PA et al., *Pain* 1996;64(3): 439.

A) Pain scores reported by children with non-painful conditions

B) Pain scores reported by children with painful conditions

Figure 2. Distribution of pain scores reported by children with non-painful and painful conditions using the Faces Pain Scale – Revised

Patients with non-painful conditions = 304; patients with painful conditions = 316.

A) Pain scores reported by children with non-painful conditions

B) Pain scores reported by children with painful conditions

Figure 3. Distribution of pain scores reported by children with non-painful and painful conditions using the Color Analog Scale

Patients with non-painful conditions = 304; patients with painful conditions = 316.

Figure 4. Pain scores associated with categories of pain intensity for the Faces Pain Scale-Revised and Color Analog Scale

The horizontal line within each box represents the median pain score. The outer margins of the box represent the interquartile range, and the whiskers represent the range of pain scores.

Figure 5. Receiver operating characteristic curves for classifying the categories of pain intensity based on the Faces Pain Scale – Revised

Each line represents the ROC curve for differentiating between each pair of adjacent categories of pain intensity.

Figure 6. Receiver operating characteristic curves for classifying the categories of pain intensity based on the Color Analog Scale

Each line represents the ROC curve for differentiating between each pair of adjacent categories of pain intensity.

Table 1

Patient characteristics

	Total Sample		Children with Painful Conditions		Children with Non-Painful Conditions	
Total (N)	620		314		306	
Mean age (SD, range)	9.2	3.8	9.8	3.8	8.6	3.7
		4–17		4–17		4–17
Age group						
Younger (4–7 years)	315	50.8%	140	44.6%	175	57.2%
Older (8–17 years)	305	49.2%	174	55.4%	131	42.8%
Sex						
Female	291	46.8%	158	50.3%	132	43.1%
Male	329	53.2%	156	49.7%	174	56.9%
Ethnicity						
Hispanic	341	55%	180	57.3%	161	52.6%
Non-Hispanic	279	45%	134	42.7%	145	47.4%
Race						
Black or African American	98	15.8%	45	14.3%	53	17.3%
White	321	51.8%	179	57%	142	46.4%
Other	40	6.4%	22	7%	18	5.9%
Don't Know	161	26%	68	21.7%	93	30.4%
Primary language						
English	552	89%	274	87.3%	278	90.8%
Spanish	68	11%	40	12.7%	28	9.2%
Painful conditions						
Soft-tissue injury			78	24.8%		
Abdominal pain			60	19.1%		
Headache			32	10.2%		

	Total Sample	Children with Painful Conditions	Children with Non-Painful Conditions
Ear or throat pain	23	7.3%	
Fracture, clinically obvious	18	5.7%	
Laceration	18	5.7%	
Chest pain	13	4.1%	
Back pain	9	2.9%	
Abscess	5	1.6%	
Other	49	15.6%	
Analgesics administered			
Ibuprofen	128	40.8%	
Acetaminophen	46	14.6%	
Parenteral opioid ¹	42	13.4%	
Oral opioid-containing analgesic ²	13	4.1%	
Ketorolac	12	3.8%	
Other	23	7.3%	
Missing data	50	15.9%	
Non-painful conditions			
Soft tissue complaint, non-painful	67	21.9%	
Fever	30	9.8%	
Rash	29	9.5%	
Cough	26	8.5%	
Vomiting and/or diarrhea	23	7.5%	
Dizziness, syncope	19	6.2%	
Shortness of breath	18	5.9%	
Other	94	30.7%	

Table 2

Mean and median scores associated with all categories of pain intensity

Categories of Pain Intensity	n	FPS-R		CAS	
		Mean (95% CI)	Median (IQR)	Mean (95% CI)	Median (IQR)
No pain	306	1.4 (1.2, 1.7)	0 (0, 2)	1.6 (1.4, 1.9)	1 (0, 2.1)
A little bit of pain	53	4.9 (4.2, 5.6)	4 (2.5, 6)	4.4 (3.7, 5.1)	4.2 (2.1, 6)
Somewhere in between	137	5.4 (5.1, 5.7)	6 (4, 6)	5.3 (5, 5.6)	5.2 (4, 6.5)
A lot of pain	124	8.2 (7.8, 8.6)	8 (8, 10)	8 (7.7, 8.3)	8 (6.8, 10)

Table 3

Optimal cutpoints for the FPS-R for differentiating categories of pain intensity

Categories of Pain Intensity Being Differentiated	n	AUC	Cutpoint ^a (95% CI)	Sensitivity	Specificity
No, mild	306, 53	0.87	3 (2–4)	0.75	0.88
Mild, moderate	53, 137	0.59	4 (4–5)	0.92	0.28
Moderate, severe	137, 124	0.84	8 (7–8)	0.77	0.86

^aThe optimal cutpoint identified is the cutpoint that best differentiates (i.e. has the highest AUC) between adjacent categories of pain severity (e.g. no pain and mild pain, mild pain and moderate pain, moderate pain and severe pain).

Table 4

Optimal cutpoints for the CAS for differentiating categories of pain intensity

Categories of Pain Intensity Being Differentiated	n	AUC	Cutpoint ^a (95% CI)	Sensitivity	Specificity
No, mild	306, 53	0.81	1 (1–2.5)	0.87	0.67
Mild, moderate	53, 137	0.63	2.75 (1.5–5)		
Moderate, severe	137, 124	0.85	5.75 (4.75–6.25)	0.77	0.80

^aThe optimal cutpoint identified is the cutpoint that best differentiates (i.e. has the highest AUC) between adjacent categories of pain severity (e.g. no pain and mild pain, mild pain and moderate pain, moderate pain and severe pain).