Caregivers’ Responses to Pain in Their Children in the Emergency Department

Ryan W. Smith, BASc; Vibhuti Shah, MD; Ran D. Goldman, MD; Anna Taddio, BScPhm, MSc, PhD

Objective: To explore physiological and anxiety responses of caregivers who witness a venipuncture being performed on their child and the effects of caregivers’ responses on child pain and distress.


Setting: Tertiary-level pediatric emergency department in Toronto, Ontario.

Participants: Fifty-five caregivers of children aged 1 month to 18 years.

Main Exposure: Observing a child receive an intravenous cannulation.

Outcome Measures: The caregiver’s heart rate, blood pressure, and anxiety (measured using a 10-cm visual analogue scale). Child-caregiver interactions were measured using the Child-Adult Medical Procedure Interaction Scale—Short Form (child age, ≥2 years) or the Measure of Adult and Infant Soothing and Distress (child age, <2 years). Child pain was measured using the Faces Pain Scale—Revised.

Results: During cannulation, there was a significant increase in a caregiver’s heart rate (median maximum difference = 12 beats per minute; \( P < .001 \)) and anxiety (median difference = 2.65 cm; \( P < .001 \)). Mean arterial pressure decreased after cannulation (median difference = 4.4 mm Hg; \( P = .004 \)). Backward linear regression revealed that 34% of the variability in child cannulation pain was predicted by caregiver anxiety and caregiver distress-promoting behavior; 31% of the variability in a child’s distress during cannulation was predicted by caregiver distress-promoting behavior. Caregiver heart rate and anxiety during cannulation and caregiver distress-promoting behavior during recovery accounted for 51% of the variability in the child’s distress during recovery.

Conclusions: Caregivers witnessing an intravenous cannulation in their child had elevated heart rate, blood pressure, and anxiety. These responses predicted child pain and distress. Future studies should evaluate interventions designed to decrease distress responses in caregivers.

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secondary objectives were to identify situational factors that predict caregiver responses as well as to determine which caregiver responses predict child pain during cannulation and child distress during both cannulation and recovery.

**METHODS**

This study was approved by the research ethics boards of The Hospital for Sick Children and the University of Toronto. Informed consent and assent (for children aged >7 years) were obtained for caregivers and children, respectively. Eligible participants were caregivers of children who required an IV cannulation while in the ED. Patients were only excluded if an IV was urgently ordered by the physician and there was insufficient time to enroll the patient in the study.

Immediately prior to IV cannulation, an oxygen saturation monitor (3900/P Oximeter; Datex-Ohmeda, Louisville, Colo) was applied to the caregiver’s right index finger and a blood pressure cuff (HEM-705CP blood pressure monitor; OMRON Healthcare Inc, Vernon Hills, Ill) was attached to his or her left arm. Caregivers were told to interact with their child in the manner they normally would. The IV cannulation procedure was divided into 3 phases for the purposes of observation: baseline (approximately 3 minutes before cannulation), procedure (cannulation), and recovery (beginning with the taping down of the cannula to the skin or withdrawal of the cannula following an unsuccessful attempt).

Immediately before the procedure, a baseline blood pressure reading was taken and the caregivers were asked to rate their anxiety using a 10-cm unmarked visual analog scale where one end of the scale indicates no anxiety and the other indicates the most anxiety possible. This scale has been used previously and has shown to be reliable and valid. Caregivers were also asked to rate their child’s baseline level of pain using the Faces Pain Scale–Revised. The Faces Pain Scale–Revised contains 6 faces depicting increasing pain with scores ranging from 0 to 10. This measure is well validated and has been used effectively in other studies in the ED setting. Thirty seconds following commencement of the IV cannulation (ie, after needle puncture), another blood pressure reading was taken and caregivers were asked to rate both their current level of anxiety (visual analog scale) and their child’s pain (Faces Pain Scale–Revised). Thirty seconds after the procedure was completed or aborted (if unsuccessful), a final blood pressure reading was taken (ie, recovery phase). The caregiver’s heart rate was monitored continuously throughout the procedure (Table 1).

The children were videotaped for the entire procedure by a video camera mounted on a tripod and placed at the end of the patient bed. In this way, the camera recorded all vocalizations or comforting measures by the caregiver throughout the procedure. From the videotapes, child-adult interactions were assessed using the Measure of Adult and Infant Soothing and Distress Scale (for children aged >2 years) and the Child-Adult Medical Procedure Interaction Scale–Short Form (for children aged ≥2 years). Child distress behaviors and adult distress-promoting behaviors were coded by the presence or absence of specific behaviors shown to be associated with child distress in 5-second intervals, according to well-established methods. Caregiver distress-promoting behaviors included reassuring comments, showing empathy, and giving physical comfort and apologies. As specified by Blount et al, these behaviors focus children’s attention on the procedure and their own distress reactions. These behaviors may also be a signal to the child that the caregiver is anxious and knows something bad is about to happen to the child. Child distress behaviors included crying, flailing, making negative emotive statements, and expressing pain verbally. Caregiver coping-promoting and child coping behaviors were also coded. These behaviors included making jokes, engaging in distraction, and nonprocedural talk or behavior. The proportion of distress behaviors and distress-promoting behaviors out of the total number of behaviors was calculated for part of each phase as follows: the first 3 minutes of baseline, the first 2 minutes after puncture of the skin, and the last 2 minutes of the recovery period. Neutral behaviors, such as the caregiver talking to the nursing staff, were not coded.

In addition, caregivers completed the parents’ opinions section of the Emotional, Activity, and Shyness Temperament Survey for Children. This temperament questionnaire is designed to gauge the child’s normal behavior tendency. Caregiver level of rest was assessed using a 5-point Likert scale where 5 indicated no sleep at all and 1 indicated best sleep possible. Caregivers were asked about their previous experiences with IV cannulation pain using an unmarked 10-cm visual analog scale where one end of the scale indicates no pain at all and the other indicates the most pain possible. Demographic information obtained from medical records included the child’s age, sex, and severity of illness. Severity of illness was rated by the triage nurse according to the following categories (from most to least ill): V, requiring resuscitation; IV, emergent; III, urgent; II, semiurgent; and I, nonurgent.

**STATISTICAL ANALYSIS**

Caregiver heart rate (median baseline to maximum recorded), caregiver anxiety, and mean arterial pressure (calculated as [(2 × diastolic blood pressure) + systolic blood pressure] ÷ 3) were compared using a Wilcoxon signed rank test. Caregiver responses were correlated with the following situational factors: child sex, child age, illness severity, child emotionality, number of ED visits (of both child and caregiver), caregiver sex, caregiver age, caregiver level of rest, number of children, level of education, and the caregiver’s previous experience with pain, using the Spearman ρ or φ coefficient, as appropriate. Factors significantly correlated with caregiver responses were entered into a backward linear regression to predict caregiver responses during cannulation, where P<.10 was used as the cut-off value for removal of individual variables in the model. In addition, caregiver responses were correlated with children’s distress and pain using the Spearman rank correlation (ρ). Backward linear regression was similarly used to identify caregiver responses that were predictive of child pain during cannulation and child distress during both cannulation and recovery.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Baseline</th>
<th>Cannulation</th>
<th>Recovery</th>
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<td>Caregiver blood pressure</td>
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<tr>
<td>Caregiver heart rate†</td>
<td></td>
<td>![check]</td>
<td>![check]</td>
</tr>
<tr>
<td>Caregiver anxiety‡</td>
<td></td>
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<tr>
<td>Child pain§</td>
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<tr>
<td>Child-caregiver interaction</td>
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</tbody>
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*Check marks denote that the measurement was performed. No entry indicates that the measurement was not performed.
†Measured continuously.
‡Self-rating, 10-cm-long visual analog scale.
§Caregiver rating using the Faces Pain Scale–Revised.

Immediately prior to IV cannulation, an oxygen saturation monitor (3900/P Oximeter; Datex-Ohmeda, Louisville, Colo) was applied to the caregiver’s right index finger and a blood pressure cuff (HEM-705CP blood pressure monitor; OMRON Healthcare Inc, Vernon Hills, Ill) was attached to his or her left arm. Caregivers were told to interact with their child in the manner they normally would. The IV cannulation procedure was divided into 3 phases for the purposes of observation: baseline (approximately 3 minutes before cannulation), procedure (cannulation), and recovery (beginning with the taping down of the cannula to the skin or withdrawal of the cannula following an unsuccessful attempt).

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<th>Recovery</th>
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<tr>
<td>Caregiver blood pressure</td>
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*Check marks denote that the measurement was performed. No entry indicates that the measurement was not performed.
†Measured continuously.
‡Self-rating, 10-cm-long visual analog scale.
§Caregiver rating using the Faces Pain Scale–Revised.
The study was conducted between March 13, 2006, and June 8, 2006. In total, 78 caregivers were approached for participation and 55 consented to the study. Reasons for declining to participate included caregivers feeling too stressed (n = 7), not wanting to be videotaped (n = 6), the child refusing (n = 3), and the caregiver being unable to speak English (n = 1). Six caregivers did not give reasons for declining to participate. No differences were found between those who consented or refused with respect to sex (P = .09) or age (P = .55) of the child. There was also no difference with respect to the severity of illness or whether the child was eventually admitted to the hospital (P = .63 and P = .08, respectively). Demographic characteristics of participating children and their caregivers are presented in Table 2.

**Table 2. Demographics of Study Participants**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
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<tbody>
<tr>
<td>Child characteristic</td>
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</tr>
<tr>
<td>Age, median ± SD, y</td>
<td>5.4 ± 4.5</td>
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<tr>
<td>Median severity of illness†</td>
<td>2</td>
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<tr>
<td>Male sex</td>
<td>30 (54.5)</td>
</tr>
<tr>
<td>White race</td>
<td>39 (79.0)</td>
</tr>
<tr>
<td>EmotionalITY,‡ mean ± SD‡</td>
<td>2.5 ± 0.9</td>
</tr>
<tr>
<td>Caregiver characteristic</td>
<td></td>
</tr>
<tr>
<td>Male sex</td>
<td>22 (40.0)</td>
</tr>
<tr>
<td>Highest education, university level</td>
<td>28 (50.9)</td>
</tr>
<tr>
<td>Relation to child</td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>31 (56.4)</td>
</tr>
<tr>
<td>Father</td>
<td>21 (38.2)</td>
</tr>
<tr>
<td>Aunt/uncle/grandparent</td>
<td>3 (5.4)</td>
</tr>
<tr>
<td>Total No. of children, mean ± SD</td>
<td>1.9 ± 1.2</td>
</tr>
<tr>
<td>No. of caregiver visits to the ED in the prior year, mean ± SD</td>
<td>1.3 ± 2.0</td>
</tr>
</tbody>
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Abbreviation: ED, emergency department.
*Values are presented as number (percentage) unless otherwise indicated.
†Denotes median of maximum heart rate during procedure.
‡Denotes median of maximum heart rate during recovery.
§Denotes range of maximum heart rate during procedure or recovery.

All analyses were performed using statistical software (SPSS, version 14.0; SPSS Inc, Chicago, Ill).

**RESULTS**

During cannulation, there was a significant increase in the caregivers’ heart rate (median maximum difference = 12 beats per minute; P < .001) and anxiety (median difference = 2.65 cm; P < .001). Caregiver mean arterial pressure was significantly elevated during cannulation as compared with recovery (median difference = 4.4 mm Hg; P = .004) (Table 3).

**FACTORS AFFECTING CAREGIVER RESPONSES**

Backward linear regression revealed that 22% of the variability in caregiver anxiety during cannulation was predicted by caregiver level of rest (β = 0.7; P = .01) and previous experience with IV pain (β = 0.3; P = .004). Eighteen percent of the variability in a caregiver’s heart rate during the procedure was predicted by the caregiver’s age (β = 0.13; P = .001), and 10% of the variability in caregiver distress-promoting behaviors during the cannulation was predicted by illness severity (β = 0.2; P = .03). Regression analysis did not reveal any factors significantly associated with mean arterial pressure changes in caregivers during cannulation.

**FACTORS AFFECTING CHILD DISTRESS AND CHILD PAIN**

To our knowledge, this is the first study to evaluate caregivers’ distress responses during IV cannulation in their children in the ED. We demonstrated that heart rate and anxiety increased in caregivers who witnessed their child undergo IV cannulation and that blood pressure was elevated until after the procedure was completed. Furthermore, caregiver responses were predictive of distress and pain responses in the child. The implication of our findings is that painful procedures performed on children in the ED can have a negative impact on caregivers who, in turn, may negatively impact their child. Thus, implementing interventions aimed at reducing stress is important for caregivers as well as children in this setting.

Alterations in physiologic indicators of stress in caregivers who are present during their children’s medical procedures have also been observed in previous studies. Kain
et al\textsuperscript{10} found that caregivers' heart rates increased significantly during induction of anesthesia in their children. Similarly, a significant increase in systolic blood pressure occurred. In addition, Parkinson et al\textsuperscript{10} reported elevated anxiety in parents of febrile children in the ED. It is important to note that in the present study, mean arterial pressure during the baseline and cannulation phases was higher than in the recovery phase. We hypothesize that the blood pressure reading we obtained at baseline was not a true baseline blood pressure, but rather that it was already elevated because of the nature of the situation, which included illness in a child and an ED setting.\textsuperscript{10} Observed increases in anxiety and caregiver heart rate in the present study may also be conservative estimates of the true differences, as these could have been elevated during the baseline phase as well.

Our study demonstrated relationships between caregiver anxiety, heart rate, distress-promoting behavior, and child pain and distress. This finding is consistent with previous literature that demonstrates an association between parent behaviors and child pain and distress during painful procedures.\textsuperscript{2,4,11-13} In the present study, child pain during cannulation was predicted by caregiver anxiety and distress-promoting behaviors. Similarly, child distress during cannulation was predicted by caregivers' distress-promoting behaviors. During the recovery phase, child distress was predicted by caregiver anxiety and heart rate during cannulation and caregiver distress-promoting behaviors during recovery. We hypothesize that caregiver anxiety and heart rate changes are predictors of child distress and that they act in a positive feedback loop. This loop begins with the presence of child illness, which leads to caregiver anxiety, elevation of physiological indices of stress, and distress-promoting behaviors. These behaviors increase child pain and distress, which then act to further increase caregiver anxiety, physiological responses, and distress-promoting behaviors, thus repeating the cycle. Whether physiologic changes precede or follow either anxiety or distress-promoting responses, however, has yet to be determined. Sequential analysis may be one method that could tease out these associations.\textsuperscript{9}

Our study found that caregiver age was predictive of heart rate changes. Younger caregivers had greater changes in heart rate compared with older caregivers. It is possible that younger caregivers are more naive about their child's conditions or worried about acute painful procedures in general from lack of experience. Furthermore, child illness predicted caregiver distress-promoting behaviors during cannulation; the sicker the child, the higher the proportion of distress-promoting behaviors was. Unsurprisingly, caregivers' anxiety was predicted by their level of rest and their own past experience with IV pain. Caregivers with higher pain during their own IV cannulations and with less rest at the time of the study reported more anxiety.

It is clear from our study that analgesic methods should be implemented to reduce stress responses in caregivers as well as children whenever possible. This is particularly important in the ED, where there is a high level of stress that is innate to this medical setting. To date, both pharmacologic and psychological interventions have been shown to reduce child and caregiver distress during painful medical procedures.\textsuperscript{21,22} In a recent study, application of a topical local anesthetic prior to IV cannulation not only reduced child pain but also increased cannulation success rate and reduced the overall procedure time.\textsuperscript{13} Moreover, educational booklets promoting parental use of distraction and relaxation techniques in children during painful medical procedures are available, and parents can be coached to use these techniques.\textsuperscript{23-25}

There are several limitations to our study. First, the use of topical anesthetics was not controlled for in the design and 13 children (24%) received them prior to the procedure. It is possible that the concomitant use of topical local anesthesia had an effect on caregiver responses, but too few children received analgesics to be able to demonstrate any significant difference between the responses of caregivers of children who received them and those who did not. Second, the presence of a child life specialist could have altered the caregivers' responses. Typically, child life specialists are used by nursing staff when nurses anticipate that the IV cannulation will be difficult. The child life specialist's role is to distract and play with the child during the procedure. The effect of the presence of a child life specialist could not be determined as it only occurred in 5 of the procedures. Third, the caregiver's position during the procedure could have affected the physiologic responses. However, this is unlikely, as caregivers maintained their position during the duration of the procedure (ie, caregivers who preferred to stand were instructed to remain standing, and those who preferred to sit remained seated). We did not find any significant differences in mean arterial blood pressure or heart rate according to caregiver position. It is important to note, however, that caregiver position may have been confounded with child age, as more caregivers with younger children chose to stand compared with caregivers of older children (P = .01). In addition, our data are limited to the first cannulation attempt. It is likely that physiologic responses and anxiety are further elevated in caregivers of children who undergo repeated cannulation attempts. Finally, our data are limited to the caregiver who consented to being monitored. In most cases, both parents were present, and it is possible that the more distressed parent was not monitored.

CONCLUSIONS

Caregivers' heart rate, blood pressure, and anxiety were affected by witnessing their child undergo IV cannulation in the ED, and these responses were predictive of child distress and pain. Analgesic interventions in the ED should involve caregivers and children.

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Author Contributions: Mr Smith had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Smith, Shah, Goldman, and Taddio. Acquisition of data: Smith. Analysis and interpretation of data: Smith, Shah, and Taddio. Drafting of the manuscript: Smith and Taddio. Critical revision of the manuscript for important intellectual content: Smith, Shah, Goldman, and Taddio. Statistical analysis: Smith and Taddio. Obtained funding: Taddio. Administrative, technical, and material support: Taddio. Study supervision: Taddio.

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REFERENCES


