

1 **Abstract**

2 **Objective:** The purpose of this study is to compare postoperative pain scores between children
3 undergoing tonsillectomy and adenoidectomy (T&A) surgery and their parents, identify potential
4 predictors for this disagreement, and determine possible impact on analgesic administration.

5 **Methods:** This is a prospective longitudinal study conducted with children undergoing outpatient
6 T&A in 4 major tertiary hospitals and their parents. Children and their parents were enrolled prior
7 to surgery and completed baseline psychological instruments assessing parental anxiety (STAI),
8 parental coping style (MBSS), child temperament (EAS) and parental medication administration
9 attitude questionnaire (MAQ). Postoperatively, parents and children completed at-home pain
10 severity ratings (Faces Pain Scale-Revised, children; Numeric Rating Scale, parents) on
11 postoperative recovery days 1, 2, and 3, reflecting an overall pain level for the past 24 hours.
12 Parents also completed a log of analgesic administration. Based on postoperative pain scores,
13 parent-child dyads were classified as overestimators (i.e., parents rated their child's pain higher
14 than children rated their own pain), in agreement (i.e., rating in agreement), or underestimators
15 (i.e., parents rated their child's pain lower than children rated their own pain).

16 **Results:** A significant proportion of parent-child pairs disagreed on pain ratings on postoperative
17 days 1-3 (30.05%-35.95%). Of those pairs in disagreement, the majority of parents overestimated
18 their child's pain on all three postoperative days, specifically such that a total of 24-26% parents
19 overestimated their child's pain on postoperative days 1, 2, and 3. Repeated measures ANOVA
20 demonstrated that parents in the overestimator group administered higher, though still within safe
21 limits, amounts of ibuprofen and oxycodone (mg/day) than did the underestimator or agreement
22 groups. Multiple regression models showed hospital site as the only independent predictor for
23 postoperative pain rating disagreement between children and parents.

24 **Conclusions:** Since parents overestimate their child's postoperative pain and may administer more
25 analgesics to their child, it is essential to develop a standardized method of child pain assessment
26 and a tailored recommended postoperative analgesic regimen amongst medical providers for
27 children undergoing T&A.

28 **1. Introduction**

29 Research indicates that up to 75% of all children undergoing surgery in the United States
30 experience significant postoperative pain.[1] A large proportion of these children suffer from pain
31 following discharge from the hospital in the home recovery phase.[2–8] In addition to the hardship
32 associated with this clinical phenomenon, children who suffer from significant postoperative pain
33 are more likely to experience delayed behavioral and clinical recovery.[2,9–11]

34 It is well established that successful management of postoperative pain requires both
35 reliable assessment of pain levels, as well as administration of the right analgesics in the right
36 dosage and at the right time.[12–16] Within home settings, parents are most often responsible for
37 managing their child’s pain following surgery [9,10] and as such, parental assessment of child pain
38 along with child assessment is of high significance. Previous research revealed conflicting results
39 regarding agreement of pain ratings between parent-child dyads. [11,14,17–19] These previous
40 studies suffer from a number of methodological flaws and have focused on describing pain rating
41 disagreement and *not* predictors or clinical impact of such disagreement. We submit that assessing
42 the impact of disagreement on actual clinical practice is of paramount importance and, if it is
43 discovered that such a disagreement does not have any impact on clinical care or outcomes, then
44 pain rating discrepancies between parents and children are less significant. In contrast, if such
45 disagreement has clinical impact, it is highly important to identify predictors for such
46 disagreement.

47 The primary aim of this study was to compare postoperative pain assessment between
48 children and their parents in a population of children undergoing tonsillectomy and adenoidectomy
49 (T&A), given this procedure is one of the most common pediatric surgeries and has been found to
50 be associated with high levels of postoperative pain.[12,20,21] The study’s secondary aims were

51 to determine if any disagreement found had clinical impact in terms of analgesic administration by
52 parents and to identify potential predictors for any disagreement found between children and
53 parents.

54

55 2. Materials and Methods

56 2.1 Participants

57 This prospective longitudinal 5-year study was funded by the Eunice Kennedy Shriver
58 National Institute of Child Health and Human Development (NICHD) and was conducted from
59 2012 to 2017. The study included children undergoing outpatient T&A surgery and their parents
60 and was aimed at evaluating a newly developed behavioral intervention that targeted reduction of
61 preoperative anxiety in children. This 5-year study consisted of: 1) a baseline phase which lasted
62 2.5 years and consisted of only data collection (no intervention), and 2) an intervention phase
63 which lasted 2.5 years and included implementation of the intervention which was detailed
64 previously. [22]

65 For the purpose of the current manuscript, we analyzed data *only* from the baseline phase
66 of the study and *not* any data following the intervention. Also, none of the analyses and data
67 presented in this manuscript have been published previously. [23]

68 Children enrolled in the 5-year study underwent surgery at Children's Hospital of Los
69 Angeles; Lucile Packard Children's Hospital at Stanford; Children's Hospital, Denver; and
70 Children's Hospital of Orange County. The average annual number of outpatient T&A surgeries
71 performed at each of these institutions was 523, 480, 1151, and 774, respectively. Children adhered
72 to the following criteria: 2-15 years old, an American Society of Anesthesiologists (ASA) physical
73 health status of I-III, and English- and/or Spanish-speaking. Exclusion criteria included children
74 with chronic illness that puts them in ASA IV (extreme systemic disorders which have already
75 become an eminent threat to life regardless of the type of treatment), developmental delays as
76 diagnosed by primary pediatrician, or born prematurely (<32 weeks gestational age). Children
77 admitted overnight were excluded from the study. These exclusion criteria were implemented

78 because children with cognitive impairments may present different responses and emotions to
79 stressors of surgery. The institutional review board at each of the four sites approved the study,
80 and informed consent and age appropriate assent were acquired from parent and child at each site.

81 Of the 1,315 eligible patients for the 5-year study, 402 declined to participate and 86
82 consented but later withdrew their consent to participate. A total of 827 parent-child dyads
83 completed the 2.5-year baseline phase. As some of the patients in the baseline phase did not report
84 their postoperative pain, only a total of 311 parent-child dyads are included in the analysis of this
85 manuscript. Because of variability in responses across postoperative days, our final sample size is
86 306, 287, and 203 dyads for postoperative ratings on days 1, 2, and 3, respectively.

87 **2.2 Measures**

88 2.21 Pain Assessment Measures:

89 **2.211 Child:**

90 Child self-reported pain was measured using the Faces Pain Scale-Revised (FPS-R), which
91 consists of a series of six faces ranging from a neutral expression (“no pain”) to an expression
92 of “most pain possible”. [24] The FPS-R has demonstrated good convergent validity to a linear
93 interval scale of observational ratings of pain, [24] excellent reliability, and is recommended
94 for use with children 4 to 18 years old. [25,26]

95 **2.212 Parents:**

96 Parents used the Numeric Rating Scale (NRS) to rate children’s postoperative pain on a 0 to
97 10 point scale. The NRS has been found to be valid, reliable, and favored by patients for its
98 high sensitivity. [27] Furthermore, prior research has found the NRS and FPS-R as functionally
99 equivalent. [16,28]

100 2.22 Psychological Measures

101 **2.221 Emotionality Activity Sociality Temperament Survey (EAS-TS)[29]**

102 The EAS-TS is a parent-reported measure of children’s temperament from early childhood to
103 adolescence in emotionality, activity, sociality, and shyness. Parents use a Likert-type scale to
104 rate their child on 20 statements reflecting temperament. We selected the EAS-TS given that
105 child temperament predicts child’s response to pain,[30] and this survey has demonstrated both
106 strong validity across temperament measures and high test-retest reliability.[29]

107 **2.222 Medication Attitudes Questionnaire (MAQ)**

108 Parents completed the self-report MAQ, which characterizes attitudes on the use of analgesics
109 to treat children’s pain. The MAQ is comprised of 27 items rated on a Likert-type scale, which
110 characterize parent beliefs on three subscales: *Appropriate Use* (e.g., “Children learn how to
111 use pain medication responsibly when it is given for pain”), *Side Effects* (e.g., “There is little
112 need to worry about side effects from pain medication”), and *Avoidance* (e.g., “Pain medication
113 works best when it is given as little as possible”).[10] Previous findings have reported the
114 MAQ to have an overall internal consistency between 0.68 and 0.73, as determined by
115 Cronbach’s Alpha.[31]

116 **2.223 State-Trait Anxiety Inventory (STAI)[32]**

117 Parent anxiety was measured using the STAI, a self-report assessment which assesses the state
118 (situational) and trait (baseline) anxiety using 20 items on a 4-point scale. The STAI-state
119 anxiety assesses respondents on how they feel at the present time, while the STAI-trait anxiety
120 assesses respondent on how they “generally” feel. Higher scores on both state- and trait-STAI
121 tests correspond to higher levels of anxiety. This measure has shown high test-retest
122 correlations, which range from 0.73 to 0.86.[32]

123 **2.224 Miller Behavioral Style Scale (MBSS)[33]**

124 Parental coping style was measured using the MBSS, a parent self-report form with strong
125 validity and reliability,[33] that presents respondents with four stressful scenarios and eight
126 possible reactions to each scenario, instructing the respondent to indicate which reaction(s)
127 they would most likely display. Respondents are characterized on two behavioral styles:
128 monitoring (high monitoring--information seeking, low monitoring—information avoiding),
129 and blunting (high blunter—distractors, low blunter—non-distractors).

130 2.23 Demographic Measures

131 Baseline demographics were collected for each parent-child dyad, including child gender,
132 ethnicity and race of child and parent, and primary language spoken at home.

133 **2.3 Procedures**

134 The day before surgery, potential participants were identified using surgery schedules and
135 determined for eligibility based on electronic medical record pre-screening. During the patient's
136 pre-surgical appointment, or on the day of surgery, researchers approached potential participants
137 in clinic or within the preoperative holding area, respectfully. After gaining consent and
138 confirming eligibility, parents and children were provided with study information documents. On
139 the day of surgery, parents completed a demographics questionnaire including gender, age, race
140 and ethnicity, education, income, etc., and several psychological surveys (MAQ, EAS-TS, STAI,
141 MBSS). These measures were completed while parents were in the preoperative holding area
142 before surgery or waiting area as their children underwent surgery. At the end of each day on
143 postoperative days 1, 2, and 3, parents completed the NRS and administered the FPS-R to their
144 child to reflect the child's overall pain level for the past 24 hours. In addition, parents documented
145 all analgesics administered to children on each of these assessment days using a questionnaire later
146 submitted to the research team. Documentation included date and time of administration, type of

147 analgesic given (ultimately decided upon by the parent), and dosage in whichever method the
148 analgesic was given (tablet, teaspoon, cc/mL, droppers, etc). If more than one analgesic was
149 administered, parents provided these same data parameters for each analgesic.

150 All clinical personnel were instructed not to change any of their standard management of
151 the patients as this was the observational longitudinal phase of the 5-year study. As such,
152 preoperative sedative premedication, parental presence during induction of anesthesia, as well as
153 the surgical, anesthetic, and analgesic course were all managed based on preferences of individual
154 anesthesiologists and surgeons. Following surgery, children were moved to the post-anesthesia
155 care unit (PACU) and subsequently met by their parents. The PACU nurse then explained
156 discharge instructions and provided directions for at-home postoperative pain management to the
157 parent and child. Instructions for pain management varied by the four hospital sites and are
158 described in Table 1. The case surgeon then returned to meet the families and provided a surgical
159 summary, answered questions, and authorized the child's discharge. Pain throughout the entire
160 perioperative period was managed per standard of care of each of the four hospitals and the
161 anesthesiologist and surgeon managing the case.

162 **2.4 Statistical Analyses**

163 Normally distributed continuous data are presented in this manuscript as means \pm standard
164 deviation; skewed continuous data are presented as medians (interquartile range); and categorical
165 data are presented as proportions. Data were analyzed with SPSS software (version 22.0; IBM,
166 Armonk, NY, USA), and $P < 0.05$ was used to determine statistical significance.

167 To determine parent-child agreement in pain ratings, we first calculated the differences in
168 pain rating between parents and children using the child FPS-R (consisting of six faces which were
169 scored 0—no pain to 10—maximum pain, with intervals of 2 points between each face) and the

170 parent NRS (recorded on a 0-10 scale). Since pain reporting data was not normally distributed, a
171 Wilcoxon Signed Ranks Test was used to determine disagreement between median parent and
172 child postoperative pain ratings on each of the follow up assessment days.[34]

173 Next, we calculated the percentage of dyads who demonstrated significant disagreement
174 between postoperative pain ratings. Previous research has identified that a difference of 20% -
175 35% in pain rating corresponds to a meaningful decrease in pain intensity.[35,36] As such, we
176 determined *a priori* that disagreement in this study between the score of the child and the score of
177 the parent will be defined as a difference of 2 or more points on the standardized 0-10 pain rating
178 scale. Once we identified which parent-child dyads were in disagreement on each of the three
179 postoperative days, all parent-child dyads included in the study were categorized into one of 3
180 groups: parents who overestimated their child's pain (OE), parents whose pain ratings were in
181 agreement with child ratings (A), and parents who underestimated their child's pain (UE).

182 Due to instances in which a parent-child dyad was inconsistent in their ratings across the
183 three postoperative days (that is, the parent may have overestimated their child's pain on one of
184 the postoperative days, and been in agreement or underestimated on another one of the days), we
185 decided that parents had to overestimate, be in agreement, or underestimate their child's pain on
186 at least two of the three postoperative days to be classified in one of the three groups. This
187 methodology eliminated 56 dyads who were inconsistent in their pain rating classifications across
188 postoperative days. These dyads were not included in the subsequent bivariate analysis to identify
189 predictors of disagreement, or in comparisons of analgesic administration between groups.

190 Analgesic administration, which accounted for both type and dosage administered by
191 parent to their child (in milligram per kilogram), was examined within each of the three groups.
192 Statistical differences of various analgesics administered over time were calculated using repeated

193 measures analysis of variance (ANOVA), where T1= postoperative day 1, T2= postoperative day
194 2, and T3= postoperative day 3, and the three groups in question were overestimators (OE),
195 agreement (A), and underestimators (UE).

196 The next phase of statistical analyses determined whether any of the collected demographic
197 and psychological variables predicted parent-child postoperative pain disagreement. Demographic
198 variables in question included: child gender, race-ethnicity, and age; parent education and race-
199 ethnicity; family marital status, household income, whether the child had undergone previous
200 surgery, child anxiety at previous medical visits, and pain level that parents expected their child to
201 endure during the current procedure. Psychological variables included the EAS-TS, MAQ, STAI,
202 and MBSS. Using the three subgroups of dyads (OE, A, UE), a chi-square calculation was
203 performed for categorical variables and a one-way ANOVA was performed for continuous
204 variables to identify potential correlations between predictor variables and postoperative pain
205 rating agreement. Results of these analyses were used to compute logistic regression models to
206 examine the relation between dyad groups and possible predictive variables, as well as to control
207 for potential confounding variables.

208

209 3. Results

210 A total of 311 parent-child dyads were included in this study. The reader is referred to
211 Table 2 for a full description of the various demographic characteristics of the population reported
212 in this manuscript. Participants primarily consisted of male children (50.2%) with a mean age of 6
213 \pm 3 years, parent respondents were primarily mothers (85.2%), and English was the primarily
214 language (74.0%).

215 3.1 *Do parents and child disagree when assessing postoperative pain?*

217 Across all postoperative days, parental median NRS scores were significantly higher than
218 child FPS-R median scores (p 's $<$ 0.05, Table 3). Using the previously defined criterion (2-points)
219 for clinically significant disagreement between parent and child pain ratings, we found that a large
220 proportion of parent-child dyads were in disagreement on postoperative day 1, 110/306 (35.95%),
221 day 2, 102/287 (35.54%), and day 3, 61/203 (30.05%) (Fig. 1). When looking only at dyads who
222 were in disagreement, in 79/110 (71.82%) of the dyads, parents overestimated on day 1; in 75/102
223 (73.52%) of the dyads, parents overestimated on day 2; and in 49/61 (80.33%) of the dyads, parents
224 overestimated on day 3.

225 3.2 *What is the clinical impact of the disagreement between parents and children?*

227 A two-way repeated measures ANOVA was conducted to examine differences in the
228 postoperative administration of ibuprofen both across time (T1, T2, T3) and group (OE, A, UE).
229 This analysis did not reveal a significant difference within groups across time (T1-3, $p = 0.575$),
230 however it did reveal borderline statistical differences across groups ($p = 0.074$). A between group
231 post-hoc analysis indicated that parents in the OE group administered more ibuprofen than did
232 parents in the A group on day 2 ($p = 0.013$) and day 3 ($p = 0.047$).

233 A second two-way repeated measures ANOVA was conducted for oxycodone and included
234 only postoperative days 1 and 2 given the sample size of children who used this medication on day
235 3 was in the single digits. We found statistically significant differences both over time ($p = 0.001$)
236 and between groups ($p = 0.000$). Post-hoc between groups analysis revealed that administration of
237 oxycodone was higher in the OE group than the A group on day 1 ($p = 0.037$) and day 2 ($p =$
238 0.004).

239 Next, we ran three individual repeated measures ANOVA tests for acetaminophen,
240 hydrocodone, and codeine consumption over days 1, 2, and 3. We found that for all these three
241 medications there was a decrease of total amount given per day as a function of the postoperative
242 day ($p = 0.001$), but that there were no group (OE, A, UE) differences for these medications.

243

244 ***3.3 Is it possible to predict which parent-child dyad will be in disagreement?***

245 In order to answer this question, we first conducted a chi-square analysis for categorical
246 variables and a one-way ANOVA for continuous variables to identify potential predictors of
247 disagreement. As can be seen in Table 4, anxiety of the child at previous medical visits ($p = 0.012$)
248 and hospital site of the study ($p = 0.005$) emerged as clinically different between the three study
249 groups. There were no other differences identified between the 3 groups for all other variables
250 tested ($p = ns$).

251 In order to control for potentially confounding variables, we next conducted logistic
252 regression models utilizing the previously identified potential predictors. Two sets of logistic
253 regression models were performed to evaluate hospital site as a predictor of group assignments.
254 The first model used hospital site to predict whether parents were more likely to underestimate or
255 agree with their child (overall significance, $p = 0.210$), and the second used hospital site to predict
256 whether parents were more likely to overestimate or agree with their child (overall significance, p

257 = 0.002). Table 5 depicts the distribution of group assignments across all hospital sites on each of
258 the three postoperative days in question. Table 6 indicates, hospital site was found to be the only
259 independent predictor for group assignment of the dyads. Specifically, overall parents were more
260 likely 5.7 times more likely to overestimate than agree with their child's pain at Lucile Packard
261 Children's Hospital as compared to Children's Hospital, Denver ($\beta = 1.749, p = 0.001, OR = 5.750,$
262 $95\% CI = 2.108-15.687$). An additional logistic regression model determined that anxiety of the
263 child at previous medical visits was not a significant predictor of group assignment ($p = 0.164$).
264 Table 7 conveys the breakdown of socioeconomic data at each of the hospital sites used to compute
265 the logistic regression model.

266 **4. Discussion**

267 The goals of the study were to identify if there is disagreement on pain rating between children
268 undergoing surgery and their parents, as well to examine if we can predict those parents and
269 children who disagreed and to examine the potential impact of this disagreement on the
270 administration of analgesics. Under the conditions of this study, we found that a significant
271 proportion of parents and children were in disagreement in determining the children's
272 postoperative pain severity in the first 3 days after surgery. Of parent-child dyads in disagreement,
273 most parents overestimated their child's pain, and those parents were more likely to administer
274 more ibuprofen and oxycodone during the postoperative course. Multiple regression models
275 showed hospital site as the sole independent predictor for postoperative pain rating disagreement.

276 Postoperative pain management is a critical factor in recovery after surgery. After
277 discharge from the hospital, parents are mostly responsible for managing their child's
278 postoperative pain. As evident in the postoperative medication instructions (Table 1), each of the
279 four sites included in this manuscript provided parents with individualized instructions for at-home
280 analgesic administration. This could be one explanation for the finding that parents at Stanford
281 were significantly more likely to overestimate their child's pain as compared to parents at other
282 sites. That is, if parents at Stanford were instructed to administer pain medication around the clock,
283 they may have interpreted this as an indication that their child should be experiencing pain and
284 would require more medication. This could potentially lead to parent-child pain rating
285 disagreement, which is supported by previous findings which have shown that parents often
286 experience difficulty in accurately identifying their child's pain level and determining the proper
287 amount of analgesics to relieve the pain.[19,37,38] It is interesting to note that the present study
288 did not identify socioeconomic status (neither in family income, nor in parental education) as

289 predictors of disagreement. This finding may even further emphasize the need for providing
290 parents highly specific instructions on postoperative pain management, for parents do not
291 necessarily rely on their own education or knowledge-base in identifying and treating their child's
292 pain. Table 7 highlights the distribution of education levels and incomes of parent-child dyads
293 amongst the four hospital sites.

294 If parents are provided a way of interpreting their child's postoperative pain, with analgesic
295 instructions that correspond to appropriate pain levels, it could mean that a more specific means
296 of identifying postoperative at-home pain levels may be imperative in reducing parent-child pain
297 rating disagreement. Previous research on parent management of child's postoperative pain at
298 home has found that 79 percent of parents found a supportive phone call to clarify instructions on
299 postoperative pain management was useful.[15] Further, current practice in most institutions
300 typically devotes more time on directions of how to assess pain and how to manage pain in the
301 PACU, rather than in the pre-surgical visit. Since parents are highly stressed on the day of surgery,
302 it is no wonder that many parents simply don't comprehend or remember these instructions from
303 the PACU. A better solution would be to provide more information preoperatively or use mobile
304 Health (mHealth) as a supportive tool.[39,40]

305 Analyses of pain medication administration found that overestimator parents provided
306 significantly more ibuprofen and oxycodone on some postoperative days than those dyads in
307 agreement. This is the first study in this area that has documented that parental overestimation of
308 pain can result, in some cases, in higher administration of analgesics by parents. Although the
309 average quantity of analgesics administered by overestimator parents was still within safe limits,
310 it is important to recognize that since the child's pain is less than assumed by the parent, it can
311 likely be treated by a lower dosage of analgesics. By recognizing appropriate pain levels and

312 administering the appropriate amount of analgesics, there is greater likelihood of avoiding higher-
313 administration, which, if severe, may result in acetaminophen-induced liver toxicity,[41] codeine-
314 associated nausea, dizziness, vomiting, and fatalities,[42] and ibuprofen-related gastric discomfort
315 or vomiting.[43] The results of this report should also be viewed within the context of the ongoing
316 debate on the opioid epidemic and the role of pain management in that epidemic. The finding that
317 hospital site was a predictor of disagreement, and that postoperative analgesic instructions varied
318 by site highlights the critical importance of providing a clear methodology of assessing and treating
319 a child’s postoperative pain, as well as clear expectations on the amount of pain that should be
320 expected. We believe, that these elements of clear instructions as well as clear expectations could
321 be used to combat the opioid epidemic within the context of postoperative pain

322 Future studies should seek to provide refined postoperative pain management instructions.
323 most postoperative pain management instructions required parents to provide analgesics “as
324 needed” based on their child’s pain (Table 1), and our findings demonstrate significant
325 disagreement in parent-child postoperative pain ratings, there is great risk of parents
326 misinterpreting their child’s pain, and therefore, providing inaccurate analgesic dosages.

327 The present study did not include highly sensitive measures to identify the impact of
328 ethnicity, but it is important to note that previous literature has shown that parental perioperative
329 anxiety and stress can be impacted by variables such as ethnicity, language, and acculturation.[23]
330 Such, it would be helpful to explore the role of these variables in affecting parental vigilance when
331 evaluating postoperative pain.

332 Though the present study did not find age to be a predictor of dyad disagreement, the data
333 showed that children of UE parents were older, on average, than children of A or OE parents (Table
334 4). This corresponds to previous literature which has shown that older children may experience

335 more pain, as well as increased analgesic use and delayed return to day-to-day functioning than
336 younger children following T&A surgery.[44,45] Since UE dyads were of higher age, on average,
337 it is worthwhile to provide specific instructions to parents of older children on potentially higher
338 pain rates. Ultimately, is of most critical importance to provide concrete directions to all parents
339 on identifying and treating child postoperative pain.

340 The results of this study should be interpreted with caution because of a number of
341 methodological limitations. We did not consider the operative surgeon, surgical technique,
342 anesthesiologist, and anesthetic techniques that all have a bearing on postoperative pain, but should
343 not affect the proportion of OE, A, and UE dyads. In the analysis of analgesics administered, we
344 did not consider the combination of codeine and acetaminophen as a separate group or those
345 patients who alternated acetaminophen with ibuprofen. Indeed, we analyzed the data for each drug
346 for the entire group, and this was done because of the small sample size of both the alternating
347 group and the combination group. The results analyzed also depend on the reliability of parents in
348 correctly recording analgesic administration, as this was not witnessed/verified by any additional
349 parties. In addition, there was substantial loss to follow-up over time, such that 306 dyads reported
350 data for postoperative day 1, as compared to 203 dyads on day 3. This drop off can be expected,
351 as parents may not be as inclined to continue recording data if the child is recovering and returning
352 to baseline function. These methodological limitations aside, we should note that this is the first
353 publication of its kind that not only describes the phenomena of disagreement in pain scores
354 between children and their parents, but also looks at the impact of these scores on analgesic
355 consumption as well as trying to identify predictors for this phenomena.

356 Conclusively, the present manuscript provides evidence that a significant portion of parent-
357 child dyads are in disagreement on children's postoperative pain ratings. Of dyads in disagreement,

358 the majority of parents overestimated their child's pain and provided substantially more analgesics
359 to their child during postoperative recovery at home. Given the substantial number of children
360 suffering from postoperative pain during home recovery, as well as the negative implications of
361 postoperative pain and overmedication, it is crucial to improve postoperative pain management at
362 home. This could be done by establishing a universal protocol used throughout hospitals on how
363 to use a pain scale in assessing child pain and tailoring pain medications based on the pain score.
364

365 **5. References**

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509

510

511 Table 1. Pain medication instructions provided by each hospital site for parents to manage their
 512 child’s postoperative pain

Site	Instructions
CHOC - Children’s Hospital Orange County	Administer acetaminophen and ibuprofen as recommended on label packaging and alternate between acetaminophen and ibuprofen for pain relief.
CHLA – Children’s Hospital Los Angeles	All parents were advised to administer acetaminophen every 4 hours as needed for pain. Parents of older children were allowed to administer Tylenol with codeine, per prescription from the surgeon (this practice was stopped in 2012). Children were not allowed aspirin or aspirin-containing medications within two weeks of surgery.
LPCH – Lucile Packard Children’s Hospital at Stanford	<p><u>Younger Children:</u> For at least the first two postoperative days and nights, administer alternating acetaminophen and ibuprofen every 4-6 hours. Specifically, administer acetaminophen, then, in 4-6 hours, administer ibuprofen, and in another 4-6 hours, administer acetaminophen. Parents should wake their children at night to continue medication, at least for the first few nights. In a few days postoperatively, parents may increase time between doses depending on child pain level.</p> <p><u>Older Children:</u> Parents may administer Oxycodone to older children every 6 hours postoperatively, in addition to alternating acetaminophen and ibuprofen regimen noted above.</p> <p><u>All Children:</u> Parents should offer children 1-2 ounces of liquid to drink during all waking hours to prevent dehydration.</p>
The Children’s Hospital, Denver	Most frequently, parents were advised to administer acetaminophen every 4 hours as needed and ibuprofen every 6 hours as needed. At the discretion of the particular surgeon performing the operation, some parents were also instructed to administer Oxycodone every 6 hours as needed in addition to the acetaminophen and ibuprofen.

513 Note: Instructions represents the practice during the years data in this manuscript was collected.

514 Important Note: In 2013, the FDA released a black box warning for the use of codeine in children <12 years of age,

515 as it may cause serious complications such as respiratory depression and death. In 2018, the FDA issued a

516 “Contraindication” to codeine in children <12 years old, and a “Warning” against its use in adolescents ages 12-18
517 who are obese or may have respiratory problems such as obstructive sleep apnea or severe lung disease.

518 Table 2. Demographic Characteristics of Respondents (n= 311). Categorical variables reported as
 519 counts and proportions. Continuous variables reported as mean \pm standard deviation.

Variable	Study Population
Child's Gender	
Male	156 (50.2%)
Female	154 (49.5%)
Missing	1 (0.3%)
Child's Age (years)	6 \pm 3
Parent Respondent	
Mother	265 (85.2%)
Father	40 (12.9%)
Other/Missing	6 (1.9%)
Parent Language	
English	230 (74.0%)
Spanish	81 (26.0%)
Parent Marital Status	
Single	36 (11.6%)
Married	218 (70.1%)
Other/Missing	74 (23.8%)
Parent Education	
<12 Years	45 (15.0%)
Graduated High School	68 (21.9%)
Some College	43 (13.8%)
College/Professional	133 (44.3%)
Missing/Prefer not to answer	22 (7.3%)
Income Bracket (Dollars)	
20,000 and under	61 (19.6%)

21,000-50,000	73 (23.5%)
51,000-100,000	51 (23.5%)
101,000 and greater	76 (24.5%)
Missing/Prefer not to answer	50 (16.7%)

Child Race/Ethnicity

White	113 (36.3%)
Hispanic	149 (47.9%)
Asian	22 (7.1%)
Other/Prefer not to answer	27 (9.0%)

Has child had previous surgery?

Yes	63 (20.3%)
No	239 (76.8%)
Missing	9 (2.9%)

521 Table 3. Parent-child pain rating agreement using Wilcoxon Signed Rank Test. Parent NRS
 522 (pNRS) and Child FPS (cFPS) scores are reported by median (range, 25%-75%).

523

Difference Between Median Parent and Child Pain Rating					
	n	Parent pNRS	Child cFPS	Parent-Child (pNRS – cFPS)	<i>p</i>
Day 1	306	6 (3-8)	4 (2-8)	+2	<.0001
Day 2	287	5 (3-7)	4 (2-6)	+1	<.0001
Day 3	203	4 (2-6)	2 (0-2)	+2	<.0001

524

525 Table 4. Analyses by chi-square (for categorical variables) and one-way ANOVA (for
526 continuous variables) to identify any potential predictors of group differences between
527 Underestimator Dyads (UE), Agreement Dyads (A), and Overestimator Dyads (OE). Categorical
528 variables are reported as percentages of total and continuous variables are reported as median
529 (interquartile range).

Predictor Variable	UE (n=16)	A (n=182)	OE (n=57)	p
<i>Child</i>				
Child Gender (Male)	50.0%	50.0%	49.1%	0.993
Child Race-Ethnicity	43.8% (Hispanic)	51.1% (Hispanic)	49.1% (White)	0.556
Child Age	8 (6)	6 (3)	5 (3)	0.108
Previous Surgery (No)	68.8%	80.8%	77.8%	0.496
Anxiety at Previous Med Visits	11.0 (36)	25.5 (43)	14 (23)	0.012*
Site				0.005*
Children's Hospital Orange County	1 (2.4%)	34 (80.9%)	7 (16.7%)	
Children's Hospital Los Angeles	5 (8.5%)	48 (81.3%)	6 (10.2%)	
Lucille Packard Children's Hospital	6 (9.8%)	32 (52.5%)	23 (37.7%)	
Children's Hospital, Denver	4 (4.3%)	68 (73.1%)	21 (22.6%)	
EAS - Emotionality	2.5 (1)	2.8 (1)	2.8 (1)	0.596
EAS - Shyness	2.2 (1)	2.4 (1)	2.6 (1)	0.491
EAS - Activity	4.6 (1)	4.2 (1)	4.2 (1)	0.802
EAS - Sociability	4.0 (1)	3.8 (1)	3.8 (1)	0.932
<i>Parent</i>				
Education (College or Professional Degree)	56.3%	42.4%	54.7%	0.917
Race-Ethnicity	56.3% (White)	48.9% (Hispanic)	54.5% (White)	0.421
Language (English)	62.5%	64.6%	80.7%	0.592
Marital Status (Married)	68.8%	75.3%	75.4%	0.236

Country Parent Grew Up In (USA)	81.3%	58.8%	57.9%	0.166
Pain level that parent expects child to experience during surgery (0-100)	60.0 (23)	61.0 (28)	55.0 (20)	0.542
MAQ – Avoidance	24.0 (13)	26.0 (15)	22.0 (12)	0.713
MAQ – Side Effects	21.0 (7)	22.0 (5)	21.0 (6)	0.104
MAQ – Appropriate Usage	22.0 (7)	20.0 (7)	20.0 (4)	0.536
STAI – State	36.2 (10)	40.0 (13)	38.0 (10)	0.924
STAI – Trait	37.0 (10)	35.5 (10)	34.0 (13)	0.897
Miller Behavioral Style – Monitoring	7.0 (4)	7.0 (5)	8.0 (4)	0.866
Miller Behavioral Style - Blunting	2.0 (2)	3.0 (2)	3.0 (3)	0.389

530 *Note: * indicates significance at $p < 0.05$.*

531

532 Table 5. Number of dyads in each (Underestimators, Agreement, and Overestimators) by
 533 hospital site on each of the three postoperative days.
 534

Hospital Site		UE	A	OE
Children’s Hospital Orange County	Day 1	2 (4.8%)	33 (82.5%)	7 (16.7%)
	Day 2	3 (7.3%)	32 (78.0%)	6 (14.7%)
	Day 3	1 (3.3%)	26 (86.7%)	3 (10.0%)
Children’s Hospital Los Angeles	Day 1	9 (15.5%)	40 (69.0%)	9 (15.5%)
	Day 2	6 (10.1%)	46 (78.0%)	7 (11.9%)
	Day 3	3 (6.7%)	34 (75.5%)	8 (17.8%)
Lucille Packard Children’s Hospital	Day 1	7 (11.5%)	35 (57.4%)	19 (31.1%)
	Day 2	6 (9.8%)	30 (49.2%)	25 (41.0%)
	Day 3	4 (11.4%)	21 (60.0%)	10 (28.6%)
Children’s Hospital, Denver	Day 1	4 (4.4%)	65 (71.4%)	22 (24.2%)
	Day 2	7 (7.7%)	61 (67.0%)	23 (25.3%)
	Day 3	3 (3.4%)	58 (65.9%)	27 (30.7%)

535 Table 6. Summary of Logistic Regression Analysis to examine the effect of demographic and
 536 clinical variables on likelihood of parents over and under-estimating their child’s postoperative
 537 pain as compared to parent-child dyads in agreement.

538
 539
 540

Predictor	β	p	Odds Ratio (95% Confidence Interval)
<i>Underestimators</i>			
Site (Lucille Packard Children’s Hospital)		0.210	
Children’s Hospital, Denver	-1.159	0.088	0.314 (0.083-1.190)
Children’s Hospital Orange County	-1.852	0.095	0.157 (0.018-1.376)
Children’s Hospital Los Angeles	-0.588	0.364	0.556 (0.156-1.975)
<i>Overestimators</i>			
Site (Lucille Packard Children’s Hospital)		0.002*	
Children’s Hospital, Denver	-1.749	0.001*	5.750 (2.108-15.687)
Children’s Hospital Orange County	0.904	0.070	2.471 (0.928-6.580)
Children’s Hospital Los Angeles	0.499	0.405	1.647 (0.508-5.337)

541 *Note: * indicates significance at $p < 0.05$.*

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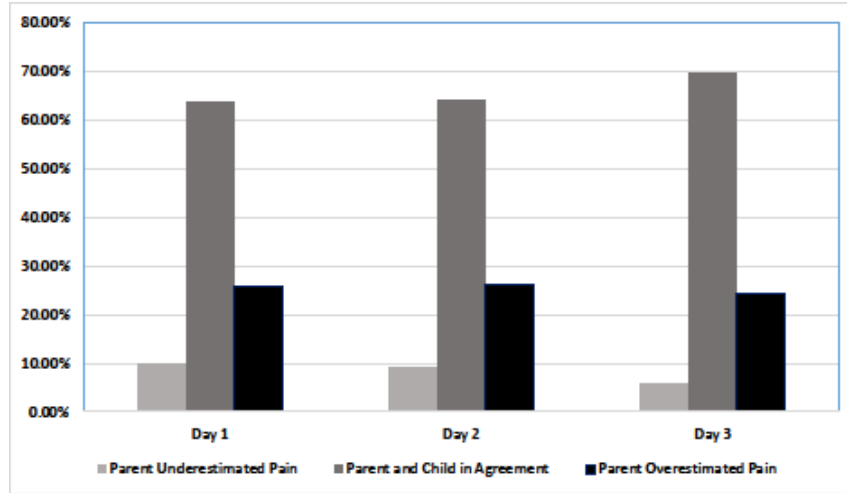
543 Table 7. Socioeconomic status of dyads grouped into either the Underestimator, Agreement, or
 544 Overestimator at each hospital site, as represented by parent respondent level of education and
 545 total family income.

Socioeconomic Measures	Children's Hospital Orange County	Children's Hospital Los Angeles	Lucille Packard Children's Hospital	Children's Hospital, Denver
Income				
20,000 and under	12 (30.9%)	19 (32.2%)	9 (14.8%)	9 (9.7%)
21,000 to 50,000	12 (28.6%)	6 (6.2%)	20 (32.8%)	14 (15.1%)
51,000 to 100,000	7 (16.7%)	7 (11.9%)	11 (18.0%)	25 (26.9%)
101,000 and greater	3 (7.1%)	15 (25.5%)	12 (19.7%)	37 (39.8%)
Missing/No answer	7 (16.6%)	12 (20.3%)	17 (27.9%)	8 (8.6%)
Parent Education				
<12 Years	6 (14.2%)	8 (13.6%)	14 (45.0%)	5 (5.4%)
Graduated High School	14 (33.3%)	9 (15.3%)	13 (21.3%)	20 (21.5%)
Some College	11 (26.2%)	7 (11.9%)	6 (9.8%)	12 (12.9%)
College/Professional	8 (19.1%)	28 (47.4%)	23 (37.7%)	52 (55.9%)
Missing/No answer	3 (7.2%)	7 (11.9%)	5 (8.2%)	6 (6.5%)

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Fig. I: Parent-Child Dyads in Agreement vs. Disagreement by pNRS and cFPS



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