

# Guidelines for Opioid Prescribing in Children and Adolescents After Surgery

## An Expert Panel Opinion

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**IMPORTANCE** Opioids are frequently prescribed to children and adolescents after surgery. Prescription opioid misuse is associated with high-risk behavior in youth. Evidence-based guidelines for opioid prescribing practices in children are lacking.

**OBJECTIVE** To assemble a multidisciplinary team of health care experts and leaders in opioid stewardship, review current literature regarding opioid use and risks unique to pediatric populations, and develop a broad framework for evidence-based opioid prescribing guidelines for children who require surgery.

**EVIDENCE REVIEW** Reviews of relevant literature were performed including all English-language articles published from January 1, 1988, to February 28, 2019, found via searches of the PubMed (MEDLINE), CINAHL, Embase, and Cochrane databases. Pediatric was defined as children younger than 18 years. Animal and experimental studies, case reports, review articles, and editorials were excluded. Selected articles were graded using tools from the Oxford Centre for Evidence-based Medicine 2011 levels of evidence. The Appraisal of Guidelines for Research & Evaluation (AGREE) II instrument was applied throughout guideline creation. Consensus was determined using a modified Delphi technique.

**FINDINGS** Overall, 14 574 articles were screened for inclusion, with 217 unique articles included for qualitative synthesis. Twenty guideline statements were generated from a 2-day in-person meeting and subsequently reviewed, edited, and endorsed externally by pediatric surgical specialists, the American Pediatric Surgery Association Board of Governors, the American Academy of Pediatrics Section on Surgery Executive Committee, and the American College of Surgeons Board of Regents. Review of the literature and guideline statements underscored 3 primary themes: (1) health care professionals caring for children who require surgery must recognize the risks of opioid misuse associated with prescription opioids, (2) nonopioid analgesic use should be optimized in the perioperative period, and (3) patient and family education regarding perioperative pain management and safe opioid use practices must occur both before and after surgery.

**CONCLUSIONS AND RELEVANCE** These are the first opioid-prescribing guidelines to address the unique needs of children who require surgery. Health care professionals caring for children and adolescents in the perioperative period should optimize pain management and minimize risks associated with opioid use by engaging patients and families in opioid stewardship efforts.

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**C**hildren and adolescents are a particularly vulnerable population in the current opioid epidemic. Adolescent opioid misuse is associated with later opioid use disorder and high-risk behavior persisting into young adulthood.<sup>1-3</sup> Prescriptions from recent surgery represent the most common reason for excess opioid pills in a child's home.<sup>4</sup> New and persistent use in children who are naive to opioids occurs at rates up to 20% after surgery.<sup>5</sup> Efforts to promote opioid stewardship among surgeons caring for children are necessary, especially in light of the recent increase in opioid-associated deaths in the pediatric population.<sup>6</sup>

In response to the opioid epidemic, several institutions and surgical collaboratives have developed opioid prescribing guidelines for adults.<sup>7,8</sup> Opioid-prescribing patterns and perceptions of opioid misuse vary widely among pediatric surgical specialties.<sup>9-13</sup> To date, to our knowledge, there are no evidence-based guidelines for opioid prescribing for children after surgery. Furthermore, use of tramadol and codeine in children persist despite US Food and Drug Administration (FDA) black-box warnings.<sup>14</sup> The goal of this review was to assemble a diverse group of health care professionals caring for children who require surgery, review literature regarding opioid use and risks unique to pediatric populations, and develop a broad framework for evidence-based opioid-prescribing guidelines.

## Methods

### Panel Composition

This guideline was developed by American Pediatric Surgical Association Outcomes and Evidence-based Practice Committee, in addition to a multidisciplinary team composed of leaders in pediatric opioid stewardship who were organizing quality improvement initiatives at their home institutions. The group was geographically diverse and included academic and community hospitals and representatives from the American College of Surgeons (ACS) Education Committee, the American Academy of Pediatrics Section on Surgery, pediatric anesthesia, pediatric nursing, general surgery residency, pediatric surgery physician assistants, and addiction science. Working groups based on topical relevance were created, and monthly teleconferences facilitated review coordination. All questions generated for the literature review and final guideline statements were reviewed and edited by patient and parent advocates. The Appraisal of Guidelines for Research and Evaluation (AGREE) II instrument was applied.<sup>15</sup> The project was exempt from review per the Children's Hospital Los Angeles institutional review board.

### Guideline Development

The American Pediatric Surgical Association Outcomes and Evidence-based Practice committee identified 3 primary questions for review:

1. What are the risks of opioid misuse, diversion, heroin use, and conversion to long-term use in the pediatric population?
2. What nonopioid regimens are effective to manage postoperative pain in children (oral, intravenous and regional) (2a)? Relatedly, what procedures do not require opioids for postoperative recovery (2b), and what are the FDA black box warnings for tramadol and codeine (2c)?
3. What teaching or preparation regarding opioid use and perioperative pain management after surgery should be provided to patients and families?

## Key Points

**Question** What are the risks of opioid misuse in children and adolescents, what nonopioid regimens effectively manage pain in children after surgery, and what education on opioid use should be provided to families?

**Findings** In this expert panel review and opinion, opioid misuse was found to occur frequently, particularly for adolescents with access to opioids, and nonopioid regimens were found to be effective to minimize or eliminate need for opioids after surgery. Families of children who undergo surgery want instruction on pain management before and after surgery.

**Meaning** Health care workers caring for children after surgery should recognize the risks of opioids, maximize nonopioid regimens, and educate families appropriately.

For each question, controlled vocabulary and associated keywords and synonyms were used to search PubMed (MEDLINE) (eMethods 1 in the [Supplement](#)), then adapted to search the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, and Cochrane databases. Opioid misuse was defined according to the National Survey on Drug Use and Health (NSDUH) (eMethods 2 in the [Supplement](#)).<sup>16</sup> The pediatric population was defined as those younger than 18 years. Retrospective reports from adults of adolescent opioid use were included. Studies limited to the neonatal intensive care setting, animal and experimental studies, case reports, non-English language articles, reviews, editorials, studies of natural orifice endoscopy (upper or lower endoscopy, cystoscopy, and bronchoscopy), emergency department procedures, venipuncture, and dressing changes were excluded.

For question 1, searches were limited to January 1988 to February 2019. Estimates of adolescent opioid misuse and diversion were obtained from the 2017 NSDUH data files (eMethods 3 in the [Supplement](#)). For question 2, searches were limited to January 1997 through February 2019. For question 2b, searches of the FDA website and associated gray literature were performed.<sup>17,18</sup> Of note, in 1992, the US Agency for Health Care Policy and Research published recommendations for health care professionals on postoperative pain management in children.<sup>19,20</sup> Key recommendations included around-the-clock opioid administration. For this reason, the review for question 3 was limited to January 2003 through February 2019.

Articles selected for inclusion underwent abstract review by each working group: opioid misuse (L.I.K.-Q., M.G.K., C.M.H., and J.E.S.), nonopioid alternatives (E.K., R.L.R., K.A.D., R.B., and J.A.), and perioperative education (H.W., C.M.H., A.B., P.G., and M.C.W.H.). Abstract review and article inclusion was determined by working group consensus, and grading of evidence was performed using the Oxford Centre for Evidence-Based Medicine 2011 levels of evidence (eTables 1 and 2 in the [Supplement](#)).<sup>21</sup> Disagreement on article inclusion was determined by working group leaders (L.I.K.-Q., R.L.R., and C.M.H.). Risk of bias was assessed using Cochrane Handbook for Systematic Reviews of Interventions.<sup>22</sup> The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed.<sup>23</sup> Overall quality of available evidence for each guideline was graded according to GRADE levels of quality (eTable 3 in the [Supplement](#)).<sup>24</sup> After conclusion of review, A Measurement

Tool to Assess Systematic Reviews-2 (AMSTAR-2) was used to grade the overall rigor of the review (eTable 4 in the [Supplement](#)),<sup>25</sup> and the protocol was registered on Open Science Framework. Outcomes measured to address literature review questions are outlined in eTable 5 in the [Supplement](#).

A 2-day in-person meeting was held, including an experience guideline facilitator (R.B.) and a nonvoting record keeper (E.M.M.). Working groups presented literature reviews, discussed quality of data reviewed, risk of bias, and preliminary guideline statements. Anonymous, real-time electronic voting (<https://www.polleverywhere.com/>) was performed. Consensus was determined using a modified Delphi technique, requiring 80% consensus.

## Results

Overall, 14 574 articles (including duplicates between concurrent searches) were screened for inclusion, with 217 unique articles included for qualitative synthesis (eFigures 1-6 in the [Supplement](#)). Twenty guideline statements (Table 1) were generated and reviewed, which were edited and endorsed by orthopedic, otolaryngology, and urologic pediatric specialists, the American Pediatric Surgical Association Board of Governors, the American Academy of Pediatrics Section on Surgery Executive Committee, and the ACS Board of Regents.

### Opioid Misuse, Heroin Use, Diversion, and Conversion to Long-term Use

We recommend all health care professionals caring for children recognize the following points.

1. A significant proportion of adolescents with access to opioids misuse them.

2. Of adolescents who misuse prescription opioids, a significant number will develop dependence or opioid use disorders.

Past-year opioid misuse increases during adolescence, peaks at ages 18 to 21 years, and decreases through ages 30 to 34 years.<sup>1</sup> Large, cross-sectional survey studies including Monitoring the Future,<sup>26-36</sup> National Monitoring of Adolescent Prescription Stimulants Study,<sup>37,38</sup> reviews of health care claims data,<sup>39-42</sup> drug monitoring data,<sup>43-45</sup> multiple survey studies,<sup>46-78</sup> and NSDUH reports<sup>79-103</sup> underscore this trend. Table 2 outlines the 2017 NSDUH prevalence estimates of past-year opioid use, misuse, and dependence for adolescents. Current levels of adolescent opioid misuse have decreased, with 17.0% (95% CI, 16.3%-17.8%) of adolescents reporting any use and 3.1% (95% CI, 2.8%-3.4%) reporting misuse, but they have not returned to their pre-opioid epidemic levels.<sup>104,105</sup> Of the 17.0% of adolescents reporting opioid use, 18.0% (95% CI, 16.1%-20.0%) also report opioid misuse. Of youth reporting opioid misuse, 13.9% (95% CI, 10.3%-18.4%) satisfy *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) criteria for opioid dependence or abuse.

3. Adolescent opioid misuse is associated with heroin use. | Six cross-sectional studies highlighted a strong association between opioid misuse and heroin use in youth.<sup>27,29,105-108</sup> Two qualitative interview studies of users of intravenous drugs report that young adults who used drugs initially misuse opioids in adolescence.<sup>109,110</sup> Early

onset and greater frequency of opioid misuse is associated with higher likelihood of heroin use.<sup>107,108</sup>

4. Prescriptions from a health care professional are the most common source of opioids for adolescents who misuse them. | Table 3 provides 2017 NSDUH data regarding sources of misused prescription opioids for adolescents. The top 2 sources for misused opioids were adolescents' own prescription (26.0% [95% CI, 20.8%-32.0%]) and diversion (39.2% [95% CI, 34.0%-44.5%]), which means receiving opioids from a friend or relative for free.<sup>16</sup> Other survey studies examining prescription opioid use provide comparable results.<sup>38,55,64,78,111,112</sup> Among adolescents who misused opioids from friends or relatives, 66.4% (95% CI, 57.1%-74.6%) reported that their friends or relatives obtained opioids from a health care professional. Overall, health care professionals are often a single step away from the adolescent who misuses prescription opioids.

5. A significant proportion of adolescents who are prescribed opioids divert them. | Prevalence of opioid diversion increases with age,<sup>113</sup> and 94% of adolescents will divert medication once approached.<sup>114</sup> Furthermore, adolescents who misuse opioids are more likely to divert opioids compared with adolescents who only use opioids as prescribed,<sup>52,115,116</sup> and adolescents who divert their own medication are more likely to satisfy *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) criteria for abuse compared with those who do not divert.<sup>114</sup> Overall, many adolescents who are prescribed opioids will be approached to divert them, and once approached, many youths will divert them.<sup>53,117</sup>

6. Adolescents who receive an opioid prescription after surgery may have a higher likelihood of future opioid prescriptions within the following year. | Among adolescents and young adults who were naive to opioids when prescribed an opioid after surgery, a study of 88 637 employer-based insurance claims reported that 4.8% of patients filled additional prescriptions within 6 months, compared with a 0.1% opioid fill rate in a comparative nonsurgical group.<sup>5</sup> A second study of 70 942 adolescents and young adults who were opioid-naive (70% ≤18 years old) found that a filled perioperative opioid prescription after wisdom tooth extraction was associated with 2.7 higher odds of persistent opioid use compared with those who did not fill an opioid prescription after extraction.<sup>118</sup> Additional studies assessing development of long-term opioid use after surgery are limited to specific diagnoses limiting generalization.<sup>119-124</sup>

### Perioperative Nonopioid Regimens

7. The optimal postoperative regimen should balance adequate pain relief for recovery while minimizing adverse effects. | The optimal postoperative regimen balances the need to control pain while also supporting recovery, from physiological stabilization and rehabilitation to returning to the classroom and sports. Prescribers should adhere to the principles of opioid stewardship and continue a stepwise philosophy of pain relief as endorsed by the World Health Organization.<sup>125-128</sup>

8. Opioid-free postoperative analgesia is feasible for many pediatric operations. | For most patients, we recommend an opioid-free recovery for the following procedures (Table 4).<sup>129-140,142-153</sup>

Table 1. Guidelines for Opioid Prescribing in Children and Adolescents After Surgery

Statement	Strength of recommendation <sup>a</sup>	LOE <sup>b</sup>	Grade of recommendation <sup>b</sup>	Grade of quality <sup>c</sup>
We recommend all health care professionals caring for children recognize that				
1. A significant proportion of adolescents with access to opioids misuse them.	****	1	A	High
2. Of adolescents who misuse prescription opioids, a significant number will develop dependence/opioid use disorder.	***	1	A	High
3. Adolescent opioid misuse is associated with heroin use.	****	1	B	Moderate
4. Prescriptions from a health care professional are the most common source of opioids for adolescents who misuse them.	****	1	A	High
5. A significant proportion of adolescents who are prescribed opioids divert them.	***	1	A	High
6. Adolescents who receive an opioid prescription after surgery may have a higher likelihood of future opioid prescriptions within the following year.	**	3	C	Low
7. The optimal postoperative regimen should balance adequate pain relief for recovery while minimizing adverse effects.	****	5	D	NA
8. Opioid-free postoperative analgesia is feasible for many pediatric operations. For most patients, we recommend an opioid-free recovery for the procedures in Table 4.	****	2	B	Moderate
9. Opioid-free postoperative analgesia may be possible for some patients after the procedures in Table 4.	****	2	C	Low
10. When discharge analgesics are deemed necessary, we recommend nonopioid option(s) as first-line treatment.	****	2	B	Moderate
11. We recommend perioperative enteral nonopioid analgesic use when clinically appropriate (Table 5).	****	2	B	Moderate
12. We recommend perioperative intravenous nonopioid medications as part of an opioid-sparing regimen.	****	2	B	Moderate
13. We recommend targeted use of perioperative regional or neuraxial anesthesia techniques as part of an opioid-sparing regimen. Effective communication between surgeons and anesthesiologists will ensure appropriate patient selection.	****	2	B	Moderate
14. We endorse the US Food and Drug Administration guidelines regarding limited use of codeine and tramadol for children younger than 18 y.	****	NA	NA	NA
15. We recommend that caregivers and children are educated about expectations and methods of pain management before the day of surgery and again perioperatively.	****	2	C	Low
16. We recommend consistent pain management messaging from all members of the perioperative care team.	****	2	B	Moderate
17. We recommend that pain management education is tailored to the caregiver's and child's needs to promote shared understanding and expectations.	****	5	D	NA
18. If opioids are prescribed, we recommend perioperative education should include instruction on possible adverse drug events, seriousness of adverse drug events, and what to do if those occur.	****	2	B	Moderate
19. We recommend educating caregivers and older children to store opioids in a secure location and properly dispose of unused medication.	****	3	C	Low
20. Health care entities caring for pediatric patients should consider providing infrastructure and means for safe opioid disposal.	****	5	D	NA

Abbreviations: LOE, level of evidence; NA, not applicable.

<sup>a</sup> Modified Delphi consensus framework: \*\*\*\* indicates strong agreement, with a recommendation of more than 80% of the votes being strongly agree or strongly disagree; \*\*\*, good agreement, with recommendation of more than 80% of the votes (strongly/somewhat agree or strongly/somewhat disagree), with more than 50% of these votes being either strongly agree or strongly disagree; \*\*, weak agreement with recommendation, with more than 80% of the votes being strongly/somewhat agree or strongly/somewhat disagree and less than 50% of these votes being either strongly agree or disagree.

<sup>b</sup> LOEs and grade of recommendation are based on the Oxford Centre for Evidence-Based Medicine 2011 levels of evidence.<sup>21</sup> The highest level of evidence available is reported. eTable 6 in the Supplement presents details on individual studies.

<sup>c</sup> GRADE levels of quality of evidence reviewed (eTable 4 in the Supplement).

**Table 2. Estimated Prevalence of Past-Year Opioid Use, Misuse, and Dependence (National Survey on Drug Use and Health 2017)<sup>a</sup>**

Type	Weighted No. (SE)	% (95% CI)		
		Population	Any use	Misuse
Any use <sup>b</sup>	4 250 372 (109 465)	17.0 (16.3-17.8)	NA	NA
Misuse <sup>c</sup>	765 645 (42 251)	3.1 (2.8-3.4)	18.0 (16.1-20.0)	NA
Abuse/dependence <sup>d</sup>	106 198 (14 122)	0.4 (0.3-0.6)	2.5 (1.9-3.3)	13.9 (10.3-18.4)

Abbreviation: NA, not applicable.

<sup>a</sup> Population includes individuals aged 12 to 17 years (weighted n = 24 942 794).

<sup>b</sup> Including medical prescription opioid use and nonmedical prescription opioid misuse.

<sup>c</sup> Nonmedical prescription opioid misuse.

<sup>d</sup> Satisfied prescription opioid *Diagnostic and Statistical Manual of Mental Disorders* abuse or dependence criteria.

**Table 3. Sources of Misused Prescription Opioid (National Survey on Drug Use and Health 2017)**

Source	Weighted No. (SE)	% (95% CI)
<b>Most recent misused prescription opioid<sup>a</sup></b>		
Got from 1 doctor	161 356 (20 817)	26.0 (20.8-32.0)
Got from more than 1 doctor	14 261 (6999)	2.3 (0.9-6.0)
Stole from doctor, clinic, hospital, or pharmacy	12 118 (5855)	2.0 (0.7-5.1)
Got from friend or relative for free	243 024 (23 051)	39.2 (34.0-44.5)
Bought from friend or relative	74 047 (15 822)	11.9 (7.7-18.1)
Took from friend or relative without asking	45 223 (9223)	7.3 (4.9-10.8)
Bought from drug dealer or other stranger	40 795 (10 716)	6.6 (4.0-10.6)
Got some other way	29 760 (8738)	4.8 (2.6-8.6)
<b>Friend or relative's source of most recent medication<sup>b</sup></b>		
Got from 1 doctor	134 772 (15 248)	66.4 (57.1-74.6)
Got from more than 1 doctor	1901 (1720)	0.9 (0.2-5.7)
Stole from doctor, clinic, hospital, or pharmacy	2628 (2629)	1.3 (0.2-8.8)
Got from friend or relative for free	17 451 (4338)	8.6 (5.0-14.4)
Bought from friend or relative	9341 (4089)	4.6 (2.0-10.5)
Took from friend or relative without asking	15 431 (6772)	7.6 (3.2-17.0)
Bought from drug dealer or other stranger	10 981 (6168)	5.4 (1.8-15.4)
Got some other way	10 435 (6059)	5.1 (1.7-14.9)

<sup>a</sup> Population was individuals aged 12 to 17 years who misused opioids in the past year (weighted n = 620 584).

<sup>b</sup> Population was individuals aged 12 to 17 years who misused opioids in the past year and reported that they had received their most recent opioid from a friend or relative for free (weighted n = 202 940).

**9. Opioid-free postoperative analgesia may be possible for some patients after some procedures.** | A list of these procedures is provided in Table 4.

**10. When discharge analgesics are deemed necessary, we recommend a nonopioid option or options as first-line treatment.** |

**11. We recommend perioperative enteral nonopioid analgesic use when clinically appropriate.** | While some procedures can be completed without perioperative opioids, nearly all procedures can be performed minimizing opioid use. Recent literature has focused on combination regimens to minimize or eliminate the use of opioids in the intraoperative and postoperative period (Table 5).<sup>129,142,154-167</sup> Five studies<sup>129,156,162,164,167</sup> evaluating rectal administration of acet-

aminophen demonstrated a decrease in opioid use with no adverse events. All studies evaluating oral regimens demonstrated either a decrease in opioid use or equivalent opioid use with improved pain scores. No studies reported adverse events, and 3 otolaryngology studies<sup>142,157,158</sup> demonstrated no increased risk of hemorrhage with postoperative oral NSAIDs after tonsillectomy. Of note, the current literature review did not include a search of complications associated with nonopioid medications, which should be considered when clinically applicable.

**12. We recommend perioperative intravenous nonopioid medications as part of an opioid-sparing regimen.** | Ketorolac was the most well-studied medication (to our knowledge) shown to be effective in reducing both postoperative pain and opioid requirements in children. Quality of studies ranged from placebo-controlled randomized studies of posterior spinal fusion<sup>168,169</sup> to observational studies of single-surgeon experiences from the 1990s.<sup>170</sup> The use of ketorolac during orthopedic procedures decreased opioid usage, postoperative pain, hospitalization costs, and length of hospital stay.<sup>168,169,171,172</sup> Randomized clinical trials of ketorolac show benefit in children undergoing inguinal hernia repair<sup>173</sup> and adeno-tonsillectomy,<sup>174</sup> with level 3 and level 4 studies showing positive outcomes in other abdominal procedures,<sup>170,175</sup> as well as the management of postoperative bladder spasm and decreasing the need for rescue analgesics for patients undergoing uretero-neocystectomy.<sup>176</sup> Care should be taken using ketorolac in children with marginal kidney function, because it can be associated with acute kidney injury, such as in children presenting with sickle cell vaso-occlusive pain crisis.<sup>177</sup>

Five articles<sup>143,178-181</sup> evaluated use of intravenous acetaminophen for the management of postoperative pain. Data suggest benefit with use of intravenous acetaminophen following inguinal hernia repair and tonsillectomy. In children undergoing abdominal procedures, 1 study<sup>178</sup> reported no decrease in opioid requirements; however, the return to normal fluid intake was quicker and parental satisfaction higher in the acetaminophen group. Of note, a recent systematic review of adults with critical illness who were receiving intravenous acetaminophen showed an increased risk of hypotension and pressor support,<sup>182</sup> although effectiveness in children with critical illness is less clear.<sup>183</sup>

Approximately 400 patients were included in 5 studies<sup>184-188</sup> evaluating dexamethasone after tonsillectomy. These studies demonstrated a decrease in postoperative opioid medication requirements while also decreasing postoperative nausea and vomiting. Dexmedetomidine has been studied in the management of patients following head and neck surgery.<sup>189,190</sup> Decreased opioid us-



Table 4. Surgical Procedures With Evidence for Opioid-Free Recovery

Procedure	LOE <sup>a</sup>
<b>Opioid-free recovery recommended<sup>b</sup></b>	
General surgery	
Inguinal hernia repair <sup>129-131</sup>	2,4
Umbilical/epigastric hernia repair <sup>12</sup>	3
Pyloromyotomy <sup>132,133</sup>	3,4
Soft tissue excision	5 <sup>d</sup>
Pectus bar removal <sup>134</sup>	5 <sup>d</sup>
Central line placement	5 <sup>d</sup>
Otolaryngology	
Myringotomy <sup>135,136</sup>	2
Urology	
Circumcision or hypospadias repair <sup>137</sup>	3
Meatotomy	5 <sup>d</sup>
<b>Opioid-free recovery possible<sup>c</sup></b>	
General surgery	
Laparoscopic procedures (eg, appendectomy <sup>138,139</sup> )	4
Nuss procedure <sup>140,141</sup>	4
Otolaryngology	
Tonsillectomy/adenoidectomy <sup>142-146</sup>	2,4
Cochlear implant <sup>147</sup>	4
Plastic surgery	
Operative burn debridement <sup>148</sup>	4
Urology	
Orchidopexy <sup>149,150</sup>	3,4
Pyeloplasty <sup>151</sup>	4
Orthopedic surgery	
Anterior cruciate ligament repair <sup>152</sup>	4
Hip or femoral surgery <sup>153</sup>	3

Abbreviation: LOE, level of evidence.

<sup>a</sup> LOEs are based on the Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence and Grade.<sup>21</sup>

<sup>b</sup> Procedures for which there was either considerable evidence ( $\geq 1$  studies and level of evidence  $>4$ ) or unequivocal biologic plausibility based on analogous and less invasive procedures in favor of an opioid-free recovery for most patients under most circumstances.

<sup>c</sup> Procedures for which there was some evidence ( $\geq 1$  studies) that an opioid-free postoperative analgesia may be possible for some patients under some circumstances.

<sup>d</sup> LOE grading of 5 indicates that the surgical incision is comparable in size and dissection with procedures listed above a procedure marked "d."

age has been reported in children undergoing tonsillectomy and alveolar bone graft when dexmedetomidine is included in the perioperative regimen. Several studies<sup>130,191</sup> evaluated the benefit of medications used in combination, including acetaminophen-ketorolac, ketamine-propofol, and ketamine-dexmedetomidine. Nonopioid medications may have synergistic effects, with additional reduction in complications, including respiratory depression.

**13. We recommend targeted use of perioperative regional or neuraxial anesthesia techniques as part of an opioid-sparing regimen.** | Effective communication between surgeons and anesthesia clinicians will ensure appropriate patient selection. Reviewed literature endorses regional anesthetic techniques, including peripheral and

Table 5. Surgical Procedures With Evidence Favoring Enteral Analgesic Administration to Decrease Opioid Administration<sup>a</sup>

Surgical specialty	Procedure(s)	LOE <sup>b</sup>
General surgery	Lower abdominal incisions, appendectomy <sup>129,154,155</sup>	2
Ear, nose, and throat	Tonsillectomy/adenoidectomy, myringotomies <sup>142,156-161</sup>	2,4
Plastic surgery	Palatoplasty <sup>162,163</sup>	2,4
Urology	Hypospadias repair <sup>164</sup>	2
Orthopedic surgery	Outpatient procedures (ie, arthroscopy, pinning, etc) <sup>165</sup>	2
Neurosurgery	Craniectomy <sup>166</sup>	4
Ophthalmology	Strabismus repair <sup>167</sup>	2

Abbreviation: LOE, level of evidence.

<sup>a</sup> Includes oral and enteral administration.

<sup>b</sup> Level of evidence based on the Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence and GRADE.<sup>21</sup>

neuraxial nerve blocks, to decrease opioid requirements for various pediatric surgical specialties, including orthopedics,<sup>148,192-198</sup> otolaryngology,<sup>199,200</sup> urology,<sup>201-211</sup> plastic surgery,<sup>212-216</sup> ophthalmology,<sup>217,218</sup> and general surgery.<sup>141,151,219-236</sup> The heterogeneity of the literature did not allow for definitive recommendations for specific surgical procedures but did illustrate overall effectiveness of regional techniques to minimize opioid use.

**14. We endorse the FDA guidelines regarding limited use of codeine and tramadol for children younger than 18 years.** | Multiple FDA advisories and warnings have been issued regarding the use of codeine in the pediatric population,<sup>17</sup> including an initial safety warning regarding the use of codeine attributable to the finding of respiratory depression in rapid metabolizers (in 2012) and a restriction in the use of codeine for children younger than 18 years who underwent tonsillectomy and adenoidectomy because of respiratory concerns (in 2013). Initial concerns regarding the use of tramadol in pediatric patients were noted by the FDA in 2015 because of reports of reduced or slow breathing following administration. Current FDA guidelines<sup>18</sup> regarding limited use of tramadol and codeine in children indicate that they are contraindicated to treat pain or cough in children younger than 12 years and pain after surgery to remove the tonsils and/or adenoids of children younger than 18 years; the FDA also warns against the use of codeine and tramadol in adolescents aged between 12 and 18 years who are obese or have conditions that increase the risk of serious breathing problems (eg, obstructive sleep apnea, severe lung disease).

### Patient and Family Education

**15. We recommend that caregivers and children be educated about expectations and methods of pain management both before the day of surgery and again perioperatively.** | Pain control is a leading concern before surgery for children and caregivers.<sup>237-240</sup> Health care professionals dedicate less than 6 minutes to pain management education on the day of surgery.<sup>241</sup> Given the limited time available and the preexisting anxiety, it is critical that education is initiated prior to the day of surgery.<sup>238,242</sup> Education should continue through discharge, because a lack of knowledge hinders parents from treating

their child's pain.<sup>243,244</sup> Parental knowledge is associated with positive attitudes toward pain medication use, better pain management strategies, and greater satisfaction.<sup>245,246</sup> Optimal timing of pain management education reduces parental anxiety, which is strongly associated with a child's preoperative anxiety and postoperative pain.<sup>247</sup>

**16. We recommend consistent pain management messaging from all members of the perioperative care team. |** Consistent pain-management messaging from all physicians, nurses, and advanced practice professionals is necessary throughout the perioperative period to increase patient and family satisfaction and alleviate confusion. Parents want consistent information, particularly around the mechanics of pain control for their children.<sup>242</sup> Given the variation in educational content on pain assessment and analgesic use, it is likely that differences exist across health care professionals within a single health care institution.<sup>239,248-259</sup> Institutions should identify a common message across all health care professionals involved in the perioperative care of pediatric patients and their families.

**17. We recommend that pain management education be tailored to the caregiver's and child's needs to promote shared understanding and expectations. |** To ensure that pain management education is accessible to all patients and their caregivers, education should be delivered both written and verbally.<sup>260,261</sup> Caregivers prefer education to be in plain, nonmedical language, regardless of health literacy level,<sup>242,261</sup> and delivered in the language most familiar to the family.<sup>262,263</sup> Lastly, additional characteristics of the child (eg, developmental abilities), caregiver, and the procedure may affect the child's postoperative recovery and should be accounted for when designing educational programs.<sup>264</sup>

**18. If opioids are prescribed, we recommend perioperative education should include instruction regarding possible adverse drug events, seriousness of adverse drug events, and what to do if they occur. |** Three studies surveyed knowledge of opioids and pain management among more than 500 parents.<sup>265-267</sup> They found that decisions to administer opioids appropriately were associated with knowledge of adverse effects of drugs and the perceived seriousness of those adverse effects (ie, oversedation).<sup>265</sup> Furthermore, education regarding opioid-associated adverse effects shifted parental understanding of perceived seriousness of adverse effects.<sup>266</sup> Lastly, only 3 parents reported receiving written instruction to hold medication if their child was sleeping, sedated, or overly sleepy.<sup>267</sup>

**19. We recommend educating caregivers and older children to store opioids in a secure location and properly dispose of unused medication. |** Despite the pervasiveness of opioid prescribing, only 32.6% of adults with younger children and only 11.7% with older children report safely storing opioids.<sup>268</sup> Moreover, few families of children who underwent surgery report disposing of opioids after the recovery period.<sup>269,270</sup> The top-cited reasons for disposing of unused opioids were an awareness of the risks and instructions from a health care practitioner.<sup>271,272</sup> In addition, the top-cited reasons for retaining unused opioids were a desire to have effective pain therapy immediately available should the patient, a family member, or a friend require pain therapy in the future.<sup>271,272</sup>

**20. Health care entities caring for pediatric patients should consider providing infrastructure and means for safe opioid disposal. |**

Approximately 30% of caregivers of adolescents who have opioids in the home did not dispose of unused opioids because they never got around to it or did not know how to do so (16%).<sup>271</sup> Opportunities exist to establish infrastructure, such as a local drug disposal box in the health care facility or home disposal mechanisms, such as drug deactivation compounds.<sup>273</sup> It is the responsibility of the prescribing institution providing inflow of opioids in the community to establish a convenient process for disposal of excess opioids.

## Discussion

Here, we present a comprehensive review of the literature regarding opioid use in pediatric populations, with a special emphasis on the needs of children and adolescents who require surgery. At project inception, the authors agreed that it was important to generate general statements on which to build a foundation of opioid stewardship. Three main themes emerged, namely that the risks of opioid misuse and dependence in pediatric and adolescent populations are significant, there is strong evidence for use of non-opioid alternatives perioperatively, and education of patients and families regarding perioperative pain management before and after surgery is paramount. Interventions based on general principles of opioid stewardship can decrease overall opioid prescribing.<sup>9</sup> Moving forward, these evidence-based and expert consensus guidelines should be used by health care professionals caring for children who require surgery to optimize pain management and minimize risk.

The parent advocate for this project communicated that educational guidelines for caregivers must stand alone because of the unique needs of families and children. The present review underscores the need for further qualitative and quantitative research on educational interventions for families to optimize understanding of perioperative pain management and appropriate opioid use, storage, and disposal. After the in-person meeting, the ACS educational representatives and members of the opioid guideline development team used studies highlighted in this review to inform the ACS patient handout on pain control for children and adolescents.<sup>274</sup> A recent randomized clinical trial<sup>275</sup> also highlighted the positive influence of providing drug disposal bags to increase proper disposal of unused opioid by families. Further work is needed to determine optimal delivery methods and retention of knowledge from educational materials, so that clinicians may deliver comprehensive, patient-centered perioperative pain management education.

## Limitations

The present review did not address several unique aspects of pain management germane to pediatric populations. Previous systematic reviews of nonpharmacological pain management strategies for pediatric chronic pain<sup>276</sup> and strategies for children undergoing emergency department procedures<sup>277</sup> reveal that there is a multitude of successful techniques proven to alleviate pain in pediatric populations (eTable 7 in the Supplement). Gabapentin may also decrease need for opioids postoperatively,<sup>278</sup> but it is currently not approved for management of acute pain in children and was

therefore omitted. Finally, while several groups have proposed procedure-specific opioid prescriptions in adults,<sup>7,8</sup> the current review did not identify similar studies in children, and results from state policy limiting opioid prescribing has been mixed.<sup>279</sup> Furthermore, the authors agreed that granular statements regarding medication dosing and timing were not supported by the current evidence.<sup>280</sup> As surgeon awareness and publications highlighting opioid stewardship increase,<sup>281</sup> we anticipate updating the present guidelines to provide recommendations outlining appropriate dosing of oral morphine equivalent after specific procedures and evidence-based storage and disposal recommendations.

## Conclusions

Optimal opioid stewardship is paramount for health care professionals caring for children who require surgery. The present review and expert panel opinion identifies 3 pillars of responsible opioid prescribing, namely, recognition of the risks of misuse and dependence associated with prescription opioid use, optimization of perioperative pain management with nonopioid alternatives, and patient and family education regarding pain management and safe opioid use practices before and after surgery.

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