
Abstract:

Abdominal pain is a common reason for emergency department visits in the United States. Failure to treat children's pain has long been considered substandard and unethical. Within the emergency department setting, pain has been repeatedly shown to be undertreated. Analgesic medications are suboptimally used for children with abdominal pain because of a wide variety of causes. To our knowledge, there is no standard of care for the treatment of such pain. As such, several recent studies have set out to determine the most appropriate methods to address this gap in knowledge. The proceeding article will attempt to review the literature as it pertains to severe acute abdominal pain, biliary colic, renal colic, and dysmenorrhea.

Keywords:

abdomen; pain; pediatrics; biliary colic; cholecystitis; renal colic; urolithiasis; dysmenorrhea

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Treating Abdominal Pain in Children: What Do We Know?

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Abdominal pain is one of the most common reasons for emergency department (ED) visits in the United States, accounting for 7.6 million visits in 2003.¹ Abdominal pain has a very large differential diagnosis. Although determining the etiology of a child's abdominal pain can be a complex task, it is essential not to lose sight of the fact that their chief complaint was just that: pain. Although every caregiver (and those children capable of comprehending) appreciates a well-explained definitive diagnosis, one would hazard a guess that they appreciate an evidence-based, well thought-out approach to treating their child's pain just as much, if not more.

Failure to treat pain has long been considered a substandard and unethical practice.² Concerns about inadequate treatment of pain in children have prompted policy statements and clinical reports by the American Academy of Pediatrics.^{3,4} There is no doubt that the pediatric community is now aware that children's pain deserves aggressive treatment for the purpose of relieving suffering. There have been significant improvements in pain assessment and management over the last decade. However, acute abdominal pain has remained somewhat off limits to analgesic treatment, primarily because of the concern by surgeons and others that pain is a crucial symptom of appendicitis and other acute abdominal processes.⁵ Even as recently as 2004, surgeons have voiced their concern that the use of analgesics may mask underlying conditions, leading to potential delays in appropriate surgical intervention.⁶

Unfortunately, current literature would suggest that emergency physicians (EPs) do not always treat pain as effectively as we

might aspire to. Within the ED setting, pain has been repeatedly shown to be undertreated.⁷⁻⁹ A recently conducted North American study assessed the current state of ED pain management and found that patients present with high levels of pain, analgesia is underused, and when used, there are significant delays in analgesia delivery.¹⁰ No standard of care exists for the management of acute abdominal pain in children. A 2003 retrospective medical record review of pathology-proven appendicitis in adults found that only 40% of patients received any analgesia in the ED.¹¹ Similarly, a Canadian pediatric ED study found that only half of children with a working diagnosis of appendicitis received analgesia.¹² In this study, 24% of those who received opioids were underdosed. The highest recorded rates of analgesia administration for abdominal pain were reported in an audit of 10 pediatric EDs across Australia and New Zealand; still, the rates only reached 62%, and the median time to parenteral medication administration was over 2 hours.¹³

The World Health Organization supports optimal pain treatment as a fundamental human right.^{14,15} Inadequate pain management during medical care, especially among children, can have longstanding detrimental effects. It can result in extended length of stay, slower healing, emotional trauma and suffering. Negative effects extend to adulthood and include fear of medical events or healthcare consultations and avoidance of subsequent medical care.¹⁶⁻¹⁸ Furthermore, inadequate analgesia in young children can reduce the effect of analgesia at a future point in time, whereas pain experiences in infants may alter future pain processing.¹⁹

Analgesic medications are suboptimally used for children with abdominal pain for a variety of reasons. Several recent studies have set out to determine the most appropriate methods to address this gap in knowledge. The proceeding sections of this article will attempt to review the literature because it pertains to severe acute abdominal pain, biliary colic, renal colic, and dysmenorrhea.

SEVERE ACUTE ABDOMINAL PAIN

Severe acute abdominal pain or the so-called suspected acute abdomen has long been a challenge for clinicians, both in terms of diagnosis and treatment. There has been great debate regarding the use of analgesics, particularly narcotics, before surgical assessment of the patient. This practice stems from the fear that treatment of the child's pain might "mask" the underlying problem, there-

by delaying definitive diagnosis and possibly resulting in morbidity. Despite advances in this area over the last 2 decades, current medical practice continues to favor the withholding of analgesia in patients with suspected appendicitis, a common cause of "acute abdomen" in children.^{20,21} Emergency physicians continue to be concerned about surgeon disapproval of their actions, despite mounting evidence to support the provision of analgesia to such patients.²⁰

A 2007 Cochrane review by Manterola et al²² included 6 randomized controlled trials of adults with acute abdominal pain. Their review supported the use of opioid analgesia in patients with acute abdominal pain to relieve discomfort; this practice did not retard the decision to treat. A recent JAMA article²³ reviewed the literature regarding opioid use in patients with acute abdominal pain. Both pooled adult (9 trials) and pediatric (3 trials) data showed statistically insignificant trends toward increased risks of altered findings on the abdominal examination after opiate administration, with risk ratios for changes in the clinical examination of 1.51 (95% confidence interval [CI], 0.85-2.69) and 2.11 (95% CI, 0.60-7.35), respectively.²³ Opiate administration had no significant association with management errors (0.3% absolute increase; 95% CI, -4.1% to +4.7%). Across studies with adequate analgesia (defined as those studies where receiving an active drug resulted in statistically lower pain scores than with placebo), opioid administration was associated with a nonsignificant absolute decrease in the risk of management errors (-0.2%; 95% CI, -4.0% to +3.6%). When focusing on the 3 pediatric trials, a nonsignificant absolute decrease in management errors (-0.8%; 95% CI, -8.6% to +6.9%) was still demonstrated.

Kim et al²⁴ studied 60 children, aged 5 to 18 years, who presented to an ED with less than 5 days of abdominal pain. They were randomized to receive either intravenous morphine (0.1 mg/kg) or placebo. Patients were examined by both pediatric ED attendings and surgical residents. This study noted no significant change in diagnostic accuracy or physical examination findings (eg, area of tenderness). Green et al²⁵ studied 108 Canadian children, aged 5 to 16 years, who presented to the ED with acute abdominal pain of less than 48 hours and required surgical consultation. The patients were randomized to receive either intravenous morphine (0.05 mg/kg) or nothing and were assessed by pediatric ED attending physicians. Morphine administration did not increase the rate of missed appendicitis, affect diagnostic accuracy, or increase the rate of perforated appendicitis. In addition,

morphine administration clinically and statistically improved the pain scores for the treated children ($P < .0001$). Kokki et al²⁶ studied 63 children, aged 4 to 15 years, with abdominal pain of less than 7 days' duration and severity greater than 5 cm of recorded pain on the Visual Analog Scale (VAS). The patients received either buccal oxycodone (0.1 mg/kg) or placebo. The same surgeon assessed the patient before and after medication administration. They concluded that early administration of oxycodone provided significant pain relief (mean difference, 13 mm; 95% CI 2, 24 mm; $P = .04$), without obscuring the surgical diagnosis. A more recent trial by Bailey et al²⁷ recruited 90 children between the ages of 8 to 18 years with the presumptive diagnosis of appendicitis and a minimum score of 5 out of 10 on a verbal numeric pain scale. These children received intravenous morphine (0.1 mg/kg) or placebo, and primary outcomes included time to surgical decision. They concluded that the use of morphine in children with a presumptive diagnosis of appendicitis did not delay the surgical decision (time to decision 34 minutes faster with morphine use; 95% CI, -105 to +40 minutes). See Table 1 for a summary of pediatric studies to date.

A knowledge-practice gap clearly remains in this clinical scenario. Multiple reviews of the use of opioids in the setting of acute abdominal pain have demonstrated that although opioids affect the physical findings on examination (usually making the tenderness less diffuse and more localized), there is no evidence to suggest that their use results in increased management error.^{23,28,29} Despite this, 76% of EPs report that they do not administer opioids before surgical assessment of their patient, whereas 85% of the same respondents felt that administration of analgesia would *not* change physical findings.²¹ Although these trials are quite convincing, there remains a need to explore optimal drug choice and dosing for opioids, analgesia effect in other pediatric populations (ie, toddlers/preschoolers, special needs children) as well as a focus on adverse event outcome rates, because these have been identified as areas in need of further refinement.^{5,28}

BILIARY COLIC

The symptom complex of biliary colic can be loosely defined as crampy abdominal pain associated with nausea and/or vomiting.³⁰ It is often epigastric or right upper quadrant in location and can occur 30 to 60 minutes after meals. This pain is associated with biliary or gallstone disease. Although still considered rare in infancy and child-

hood, cholecystitis and cholelithiasis are now being recognized with increasing frequency. Adult population studies estimate that cholelithiasis occurs in up to 20% of women and 8% of men in Europe and the United States.³¹ Ultrasound-based studies in the pediatric population put estimates for children closer to 0.13% to 0.22%.³²

Cholecystitis is inflammation of the gallbladder wall, whereas cholelithiasis is defined as the presence of gallstones in the gallbladder. The term *biliary dyskinesia* is typically used to describe a motility disorder of the biliary tract that can be further divided into 2 main categories: gallbladder dyskinesia and sphincter of Oddi dysfunction. Gallbladder dyskinesia causes typical biliary colic symptoms without gallstones, whereas sphincter of Oddi dysfunction typically presents with chronic abdominal pain or chronic pancreatitis, often postcholecystectomy. Biliary dyskinesias are also quite uncommon in children, and insufficient data exist to determine the true incidence of these diagnoses in children.³³ Like cholecystitis, most pediatric patients with biliary dyskinesia are female. (See Table 2 for a summary of definitions.)

Patients with typical biliary colic need pain management, and they are frequently prescribed opioids. Although lacking definitive evidence, a low-fat diet to decrease biliary and pancreatic secretions is often considered. Empiric trials with proton pump inhibitors, fiber supplements, anticholinergics, antispasmodics (ie, hyoscine butylbromide), prokinetic agents, tricyclic antidepressants, and acupuncture are occasionally offered as well.^{31,33} Although these interventions may be effective in some, many patients do not gain any benefit.³¹ Drugs to relax smooth muscle, such as calcium channel blockers (eg, nifedipine) and nitrates, have demonstrated short-term relief in the adult population.³⁴ However, there is a lack of data on long-term efficacy, and concerns regarding the cardiovascular adverse effects of these drugs are not to be overlooked.

Given the infrequency of occurrence of biliary colic in children (relative to other causes of abdominal pain), there remains a paucity of research specific to pain treatment in pediatrics. In fact, reviews of the topic often have a cursory discussion of the pharmacotherapy of pain; they tend to focus on definitive therapy, in the form of surgery.^{31,32,35} Although laparoscopic cholecystectomy remains the first-line therapy for symptomatic gallstones, as EPs, we are often in the position of needing and wanting to offer temporizing pain therapy while awaiting definitive diagnosis or surgery. As such, we need to be familiar with the current literature, as limited as it may be. Recom-

TABLE 1. Summary of pediatric studies of opioid use for severe abdominal pain.

Study	Study Design	Study Population	Objective	Intervention	Outcome	Conclusion
Bailey et al ²⁷	Randomized double-blind placebo-controlled	Aged 8-18 y, presumptive diagnosis of appendicitis, pain scale 5 on VAS (n = 90)	To evaluate the efficacy of morphine before surgical consultation in children with right lower quadrant pain suggestive of appendicitis and determine whether it has an impact on the time to surgical decision.	Morphine 0.1 mg/kg IV or placebo; assessment of pain at 0 and 30 min; analyzing time between arrival at the ED and surgical decision.	There was no important difference in the decrease of pain between the morphine (n = 45) and placebo (n = 42) groups 30 min after medication: 24 ± 23 mm and 20 ± 18 mm, respectively (difference of 4 mm [95% CI -5 to 12 mm]). There was also no important difference in the time between arrival in the ED and the surgical decision: median, 269 min (95% CI, 240-355 min) for morphine and 307 min (95% CI, 239-415 min) for placebo (difference of 34 min [95% CI -105 to 40 min])	The use of morphine in children with a presumptive diagnosis of appendicitis did not delay the surgical decision.
Green et al ²⁵	Double-blinded, randomized, placebo controlled	Aged 5-16 y, patients felt to require surgical consultation for acute abdomen (n = 108)	To determine if the administration of morphine would impede diagnosis of acute appendicitis; to determine the efficacy of morphine in relieving the pain.	Randomized to receive 0.05 mg/kg IV morphine or placebo. MD's confidence in clinical diagnosis was recorded before administration of medication and then 15 min after administration. Surgeon filled out a similar form within 1 h. Pain also recorded.	No differences between groups in diagnosis of appendicitis (7/7 in morphine group, 4/6 in placebo group, <i>P</i> = .25) or perforated appendicitis (3/7 in morphine group, 1/6 in NS group, <i>P</i> = .51) or the number of patients who were observed and then underwent laparotomy (7/19 in morphine group, 6/22 in placebo group, <i>P</i> = .29). Reduction in mean pain score was much higher with morphine (2.2 vs 1.2 cm, <i>P</i> = .015). The ED physician and surgeon's confidence in their diagnosis was not affected by administration of morphine.	Morphine does not impede diagnosis of acute appendicitis. In addition, it effectively reduces pain intensity in patients with acute abdominal pain.

Kokki et al ²⁶	Prospective, randomized, double blind, and placebo controlled	Aged 4-15 y, children with acute abdominal pain <7 d, pain scale 5 on VAS (n = 104)	To determine efficacy of buccal oxycodone on pain relief, physical examination findings, diagnostic accuracy, and final outcomes.	Patients randomized to receive 0.1 mg/kg buccal oxycodone or placebo. Surgeon evaluated patient at times 0, 1.5, and 3.5 h. Pain scores (on VAS) recorded at 30-min intervals for 3.5 h	The pain intensity difference was significantly greater in the oxycodone group, 22 ± 18 cm, than in the placebo group, 9 ± 12 cm (mean difference, 13 cm, with a 95% CI, 2-24 cm; P = .04). The diagnostic accuracy increased from 72% (23/32) (predose) to 88% (28/32) (postdose) in the oxycodone group and remained at 84% (26/31) (pre- and postdose) in the placebo group after drug administration.	Buccal oxycodone provides significant pain relief, does not alter clinical signs, or does not obscure surgical diagnosis.
Kim et al ²⁴	Randomized, double blind, placebo controlled	Aged 5-18 y, with abdominal pain 5-d duration, pain score 5 on VAS, requiring surgical consultation (n = 60)	To evaluate effects of IV morphine on pain relief, physical examination findings, and diagnostic accuracy.	Randomized to morphine 0.1 mg/kg or placebo. PEM MD and surgeon each recorded findings and their diagnoses at time 0 and 30 min.	The median reduction of pain score between the 2 groups was 2 (95% CI, 1-4; P = .002). Patients with surgical conditions had persistent tenderness to palpation and/or percussion. No significant change in the diagnostic accuracy between the study groups and between the physician groups was noted.	IV morphine provides significant pain relief without adversely affecting the abdominal examination.

TABLE 2. Causes of biliary colic.

Condition	Definition
Cholecystitis	Inflammation of the gallbladder
Cholelithiasis	Presence of gallstones in the gallbladder
Biliary dyskinesia	Motility disorder of the biliary tract
1. Gallbladder dyskinesia	Biliary colic symptoms without gallstones
2. Sphincter of Oddi dysfunction	Chronic abdominal pain or chronic pancreatitis often postcholecystectomy

recommendations regarding the best approach to pain treatment stem mainly from adult studies.

In the acute setting, nonsteroidal antiinflammatory drugs (NSAIDs) (e.g. ketorolac) and opioids (e.g. morphine) have been used successfully, both in combination and separately. Ursodeoxycholic acid has been shown to be useful in preventing gallstones.³⁶ However it does not seem to be useful once stones have developed. A prospective, randomized, double blind, placebo-controlled trial from the Netherlands in 177 highly symptomatic patients with gallstones scheduled for cholecystectomy found that ursodeoxycholic acid did not reduce biliary symptoms.³⁷

A 2008 systematic review and meta-analysis looked at antiinflammatory drug use for biliary colic in the ED.³⁸ They included 7 adult patient-based randomized controlled trials comparing parenteral (intravenous [IV] or intramuscular [IM]) NSAIDs to either opioids or antispasmodic medications and analyzed a total of 349 patients. This review demonstrated a benefit in favor of NSAIDs, with a lower need for rescue analgesia when NSAIDs were used (odds ratio [OR] = 0.32; 95% CI, 0.16-0.61). Interestingly, there was also less progression to acute cholecystitis (OR = 0.19; 95% CI, 0.08-0.44), which might be explained by the antiinflammatory properties of NSAIDs. The authors concluded that, given the current state of evidence, NSAIDs would be the analgesic of choice for uncomplicated biliary colic in the ED. Applicability of these results to children is limited because of adult-only studies being included and the overall small number of patients in these analyses.

Biliary colic can be due to a number of pancreaticobiliary etiologies. Its prevalence is low in children, when compared with adults, and thus, much of the management literature is extrapolated from adult-based studies. Based on currently available best evidence, parenteral NSAIDs would appear

to be the treatment of choice for children and adolescents with acute biliary colic in the ED. The aforementioned review included studies that used IM flurbiprofen, IV ketorolac, IV tenoxicam, IM diclofenac, and IV indomethacin. Further studies will need to focus on both which NSAID and at what optimal dosing is best suited for pediatric patients.

RENAL COLIC

Renal colic is defined as an acute syndrome involving unilateral flank pain, linked to an obstruction in the upper urinary tract. It is frequently associated with renal stones (i.e. urolithiasis). There has been much speculation regarding the perceived increase in pediatric urolithiasis in recent years. This was further thrust into the spotlight by the recent increase in renal stones after infant consumption of melamine-laced infant formula in Asia.^{39,40} The prevalence of urinary stones varies widely by geographic region, with the disease an endemic problem in certain developing regions of the world, including the Far East, parts of the Middle East, and Turkey.⁴¹ In contrast, stones are uncommon in African American children. Within the United States, renal stones account for 1 per 1000 to 1 per 7600 pediatric hospital admissions.⁴¹ Although research related to pain management of acute stone events has been active in the adult literature,^{42,43} there has been very little research on the medical management of the child with renal colic. Pediatric literature seems to have been limited to case series of rare presentations such as uric acid stones, in which treatment of pain was not the primary focus.⁴⁴

The mainstay of current therapy for renal colic includes NSAIDs and opioids. Traditionally, most studies have looked at parenteral use of these drugs because renal colic tends to present acutely and severely, thereby necessitating the use of drugs with rapid onset. Several alternative and adjunctive therapies have also been explored over the last decade. Unfortunately, much like biliary colic, there is a paucity of evidence that is specific to children. This is due in large part to the fact that renal colic is most commonly diagnosed in adults. Thus, we must look to the adult literature for some direction regarding optimal analgesia for children with acute renal colic.

A 2004 Cochrane review studied NSAIDs vs opioids for acute renal colic. Holdgate and Pollock⁴² included 20 trials, with a total of 1613 patients. Most trials used intravenous or intramuscular medications. Because of unexplained heterogeneity, the results of individual trials could not be pooled,

although 10 of the 13 studies reporting pain scores demonstrated lower pain scores in patients receiving NSAIDs over opioids. NSAIDs were shown to be less likely than opioids to cause nausea; this is important, considering that patients may already be nauseated by their renal colic, and exacerbation could lead to further discomfort. Patients with NSAIDs were also less likely to require rescue analgesia. Overall, it would appear that NSAIDs would be the appropriate first-line choice for analgesia in renal colic.

When NSAIDs are used for renal colic, parenteral administration should be employed, because pain relief is achieved far quicker than by the enteral route.⁴⁵ To our knowledge, ketorolac is the only parenteral NSAID available in North America. Rectal NSAIDs have been compared with intravenous NSAIDs in 2 studies.^{46,47} These studies suggest that although rectal NSAIDs do provide analgesia for adult patients, the onset of analgesia is delayed with the rectal route. Although the evidence is not definitive, these trials do suggest an alternative route to providing NSAIDs to a vomiting child with difficult or delayed intravenous access. When one agent does not achieve adequate pain relief, one should consider combining an NSAID and an opioid agent. The trial of Safdar et al⁴⁸ of 130 patients demonstrated that the analgesic effect of combining morphine with an NSAID was greater than either agent alone.

A 2005 Cochrane review focused on therapies that might increase fluid flow through the affected kidney to expedite stone passage, thereby improving symptoms more quickly.⁴⁹ Interventions of interest were high volume intravenous or oral fluids and diuretics. Unfortunately, not a single credible trial was identified through this review. Given their potential positive impact, the role of diuretics and high volume fluid therapy in acute ureteric colic should be examined to determine their safety and efficacy in facilitating stone passage and improving analgesia.⁴⁹

Scopolamine (ie, hyoscine, Buscopan) is the only antispasmodic medication for renal colic that has been studied in a randomized controlled trial. Holdgate and Oh⁵⁰ included 192 adult patients and randomized them to receive either 20 mg of scopolamine or placebo, in addition to their pain medications. Patients in the scopolamine group required a median IV morphine dose of 0.12 mg/kg, whereas the placebo group required 0.11 mg/kg; this difference was neither statistically nor clinically significant. They concluded that adding scopolamine to morphine did not provide improved patient analgesia. Notwithstanding, the role of

antimuscarinic medications such as scopolamine in facilitating the passage of stones (through smooth muscle relaxation) remains to be determined.

Nifedipine (a calcium channel blocker) and tamsulosin (an α -blocker) have been used as adjunct therapy for the treatment of renal colic.^{51,52} Although they are not analgesics, some studies have suggested that they might improve the rate of stone expulsion (which is ultimately the therapeutic goal) and may also decrease the need for analgesia.⁵³⁻⁵⁶ Although one might consider judicious use of such medications as adjuncts, definitive evidence is still lacking, and it is important to recall that they do not treat pain and should not be used as monotherapy.

Desmopressin and steroids have also been considered in the pharmacologic management of renal colic. Although there is some early evidence to suggest that desmopressin, a structural analog of antidiuretic hormone, might improve both analgesia and renal pelvic pressure, the evidence regarding safety and efficacy remains preliminary at this time.⁵⁷ Although used, to our knowledge, acetaminophen has not been evaluated in the treatment of renal colic.

Alternative methods for providing analgesia in renal colic include heat therapy and acupuncture.⁵⁸ Local active warming to 42°C was effective in treating pain in one prehospital trial.⁵⁹ One hundred patients were randomized to receive either active heating to 42° or passive warming (a simple blanket). Pain was reduced by 50% with the active warming, even before arrival to the hospital. Similarly, anxiety and nausea were lowered to a statistically significant degree. This intervention is simple and inexpensive. It could serve as a powerful adjunct to analgesic pharmacotherapy and merits further exploration. In the study of Lee et al,⁶⁰ acupuncture was compared with an intramuscular NSAID and found to be comparable in effect, although the analgesic effect of the NSAID was of more rapid onset.

In summary, renal colic is an uncommon pediatric ED presentation and much of our evidence stems from adult literature. The adult experience with the treatment of the pain associated with renal colic would suggest that intravenous NSAIDs (eg, ketorolac) are an appropriate first-line therapy. Intravenous opioids (eg, morphine) can also be considered because they have an effect comparable with NSAIDs (Table 3). Although narcotics are associated with higher adverse effect profiles, they may also have the benefit of quicker onset of analgesia. Thus, some advocate for the combination of both agents if a patient has severe renal colic. Otherwise, mild-to-

TABLE 3. Pharmacotherapy for renal colic.

Therapeutic Agent	Pediatric Single Dosage (PO/PR/IV)
NSAIDs	
Diclofenac (Voltaren)	1 mg/kg PO (max 50 mg)
Ibuprofen	10 mg/kg PO (max 600 mg)
Ketorolac (Toradol)	0.5 mg/kg IV (max 30 mg)
Opioids	
Morphine	0.05-0.1 mg/kg IV
Oxycodone	0.1 mg/kg PO

PO = per oral; PR = per rectum; IV = intravenous.

moderate pain could be approached in a stepwise fashion, with opioids added as a second-line agent if NSAIDs are inadequate. Of note, patients with known renal insufficiency or pregnant women should not be routinely prescribed NSAIDs. There are some promising new studies supporting the use of various adjuvants, including warming and various drugs (Table 4). These areas need to be further explored to determine their use in the treatment of renal colic in children.

DYSMENORRHEA

Dysmenorrhea, or painful menses, is defined as menstrual cramps and other menstrual-related symptoms. The pain is described as crampy, spasmodic, and labor-like and is typically felt in the lower abdomen and suprapubic area.⁶¹ A myriad of symptoms (including nausea, vomiting, headache, diarrhea, fatigue, low back pain, and dizziness) may be associated. Primary dysmenorrhea is painful menstruation in the absence of specific pathologic abnormalities.⁶¹ Potent prostaglandins and leuko-

trienes play an important role in the symptoms. It is the most common gynecologic complaint in women and the leading cause of school/work absenteeism among female adolescents.^{62,63} In a study of Swedish adolescents, almost 75% of the young women reported experiencing dysmenorrhea.⁶⁴ American studies of dysmenorrhea report up to 50% of girls reporting school absenteeism related to their symptoms. Patients with more severe cramps report missing more school. Interestingly, despite this being such a common problem, many do not seek advice or are undertreated.⁶⁵ During times of pain crisis, these patients may present to the ED looking for acute relief.

Many practitioners consider NSAIDs as first-line therapy for dysmenorrhea. NSAIDs reduce prostaglandin production, which results in less vigorous uterine contractions, and subsequently, less pain. A 2010 Cochrane review studied the role of NSAIDs in dysmenorrhea.⁶⁶ When compared, no NSAID has emerged as clearly superior to the others. DuRant et al⁶⁷ conducted a study of 45 adolescent females with dysmenorrhea and randomized them to 1 of 5 naproxen sodium regimens. Use of a 1-time loading dose of naproxen (550 mg, twice the normal dose) was associated with greater improvement of symptoms than a single “regular” dose (275 mg) (Table 5).

If unresponsive to NSAIDs after a period of approximately 3 cycles, combined estrogen/progestin oral contraceptive pills (OCPs) are sometimes recommended for the treatment of dysmenorrhea.⁶⁸ However, a 2009 Cochrane review of oral contraceptive therapy for primary dysmenorrhea demonstrated limited evidence for pain improvement.⁶⁹ This review included 10 trials and 5 low- and medium-dose estrogen studies, totaling 497 women, suggesting pain improvement with a pooled OR of 2.01 (95% CI, 1.32-3.08). A sensitivity analysis removing studies with inadequate allocation concealment, while still demonstrating benefit of treatment (OR, 2.99; 95% CI, 1.76-5.07), revealed heterogeneity in the results, bringing the strength of the conclusions into question. Thus, the authors concluded that there was limited evidence to suggest that OCPs were effective in reducing pain in primary dysmenorrhea. If used, they suggested low-dose estrogen pills. Of note, of course, is the fact that OCPs have not been shown to provide immediate pain relief in the ED setting.

Many nonpharmacologic therapies have been advocated for the treatment of dysmenorrhea (Table 6). These include transcutaneous electronic nerve stimulation (TENS),⁷⁰ acupuncture,⁷¹ diet manipulation,⁷² increased physical activity,⁷³

TABLE 4. Renal colic therapies still under investigation.

Therapy	Mechanism of Action
Scopolamine	Antispasmodic, antimuscarinic
Nifedipine	Calcium channel blocker, may improve rate of stone expulsion
Tamsulosin	α -Blocker, may improve rate of stone expulsion
Desmopressin	Structural analog of antidiuretic hormone, may improve renal pelvis pressure
Steroids	Decrease swelling in urinary tract
Heat therapy	Pain therapy
Acupuncture	Pain therapy

TABLE 5. Pharmacotherapy for dysmenorrhea.

NSAID	Pediatric Single Dosage
Naproxen	5-10 mg/kg PO (max 550 mg)
Ibuprofen	10 mg/kg PO
Low-dose estrogen OCPs	-

dietary supplementation with omega-3 fatty acids,⁷⁴ and topical heat therapy.⁷⁵ All of these interventions have been reported as showing some benefit in dysmenorrhea. A Cochrane review of high-frequency TENS for the treatment of dysmenorrhea found it to be superior to placebo/sham TENS.⁷⁶ However, the TENS group did experience more adverse effects, and the sample size was too small to draw definitive conclusions regarding this therapy. A 2008 Cochrane review of Chinese herbal medication for primary dysmenorrhea attempted to summarize the available evidence.⁷⁷ Thirty-nine randomized controlled trials (RCTs), with a total of 3475 patients, were included. Chinese herbal medicine resulted in significant improvements in pain relief (14 RCTs; relative risk [RR], 1.99; 95% CI, 1.52-2.60), overall symptoms (6 RCTs; RR, 2.17; 95% CI, 1.73-2.73), and use of additional medication (2 RCTs; RR, 1.58; 95% CI, 1.30-1.93) when compared with use of pharmaceutical drugs. Self-designed Chinese herbal formulations resulted in significant improvements in pain relief (18 RCTs; RR, 2.06; 95% CI, 1.80-2.36), overall symptoms (14 RCTs; RR, 1.99; 95% CI, 1.65-2.40), and use of additional medication (5 RCTs; RR, 1.58; 95% CI, 1.34-1.87) after up to 3 months of follow-up when compared with commonly used Chinese herbal health products. Chinese herbal medicine also resulted in better pain relief than acupuncture (2 RCTs; RR, 1.75; 95% CI, 1.09-2.82) and heat compression (1 RCT; RR, 2.08; 95% CI, 2.06-499.18). Unfortunately, a large number of the trials

TABLE 6. Possible nonpharmacologic therapies for dysmenorrhea.

Transcutaneous electronic nerve stimulation
Acupuncture
Diet manipulation
Increased physical activity
Dietary supplementation with omega-3 fatty acids
Topical heat therapy
Chinese herbal medication
Behavioral therapy

had varying herbal products that were studied, small sample sizes and/or poor methodology. The authors cautioned readers to interpret the review with care, given these significant limitations. Much of the evidence regarding nonpharmacologic therapy for dysmenorrhea is still too immature to draw any definitive conclusions, at this time.

A 2007 Cochrane review of behavioral interventions for primary and secondary dysmenorrhea included 5 trials, for a total of 213 patients.⁷⁸ The studies showed mixed results for relaxation therapy, with some reduction in pain and improved levels of activity. Similar to Chinese herbal medicine, the quality of the included trials was questionable, with inconsistencies in data reporting, small sample size, and poor methodology.

In summary NSAIDs appear to have emerged as the first-line therapy for acute pain caused by primary dysmenorrhea. Hormone manipulation, through the use of OCPs, can be considered with low-dose estrogen pills, although this will likely not result in immediate pain relief. There is a myriad of nonpharmacologic therapies that may help as well. It may be worthwhile to discuss these options with your patient, tailoring the conversation to their preferences, because the evidence is still lacking to definitively recommend one choice over the other.

SUMMARY

Acute abdominal pain is common in the pediatric population and challenging in its management. Overall, emergency care providers need to optimize the measurement, documentation, and treatment of pain in children. NSAIDs have emerged as a very strong candidate for the treatment of many different types of pain, including abdominal pain.^{79,80} As we continue to refine the pediatric evidence surrounding NSAIDs, it is important to focus on determining the optimal drug/dosing combination and, most importantly, the safety profile specifically as it pertains to children.

Opioids have and will always remain a choice in the treatment of moderate to severe pain in children. Attention must be paid to choosing the optimal dose when treating children because many studies have demonstrated underdosing. When considering opioids, those dependent on certain metabolic pathways (eg, codeine and CYP2D6) should be used with consideration of the highly variable response that occurs between ethnic groups. If it is difficult to define this metabolic variability within your patient population, then the use of opioids that do not require such metabolism (eg, oxycodone) should be considered.

Alternative and nonpharmacologic therapies are gaining popularity. Currently, there is little definitive evidence in the field, but much in the way of promising leads for future exploration. Some involve minimal effort or expense (eg, heat therapy for renal colic or relaxation for dysmenorrhea) and may be useful adjuncts to traditional pharmacologic therapies. ❑

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