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State of the art in biobehavioral approaches to the management of chronic pain in childhood

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Practice points

- The experience of chronic pain in youth is common, particularly among adolescent females, and is complex, typically occurring within a biopsychosocial framework.
- Chronic pain in childhood can result in grave deficits in physical and emotional functioning and persist into adulthood.
- Currently, psychological treatments utilize cognitive-behavioral therapy (CBT), which has shown positive results in this population. The CBT approach involves some combination of psychoeducation, self-regulation training, cognitive reappraisal, behavioral exposure and parent involvement.
- Emerging areas within the psychological treatment of chronic pain in childhood include group and internet-based CBT, motivational interviewing and comorbid obesity interventions.
- Multidisciplinary pediatric pain programs are growing in numbers and demonstrate positive findings. However, complex patients often require intensive interdisciplinary pain treatment, involving physical, occupational and psychological therapy components for patients and parents over a several week period.
- Future considerations should involve matching patients to psychological treatments based on their individual characteristics, as opposed to grouping patients by diagnostic pain categories.
- Emerging screening tools that allow for stratification of patients by risk of poor clinical outcome provide a way to enhance the accuracy of treatment recommendations.
- Targeting of pain-related fear, attentional biases and comorbid conditions has emerged within the adult pain population and should be applied to children and adolescents.

Chronic pain in childhood is prevalent, persistent and significantly impactful on most domains of life. The chronic pain experience occurs within a complex biopsychosocial framework, with particular emphasis on the social context. Currently, psychological treatments involve a cognitive-behavioral therapy treatment plan, providing some combination of psychoeducation, self-regulation training, maladaptive cognition identification, behavioral exposure and parent involvement. New treatment areas are emerging, such as group- and internet-based cognitive-behavioral therapy, motivational interviewing, comorbid obesity intervention and intensive multidisciplinary rehabilitation. Preliminary studies of emerging treatments demonstrate encouraging results; however, treatment effectiveness hinges on accurate matching of patient to treatment modality. Overall, the current direction of the field promises many innovative breakthroughs to ameliorate suffering in youth with chronic pain.

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Scope of the problem

• Prevalence

Chronic pain in childhood is a significant public health concern with median prevalence rates of 11–38% [1], with 3–5% of children suffering from significant pain-related disability [2,3]. Although prevalence rates vary dramatically across pain conditions, headache pain is most common, occurring in 8–83% of children. Other common pain conditions include abdominal pain (4–53%), musculoskeletal pain (4–40%) and back pain (14–24%) with many children reporting multiple pain complaints (4–49%). Pain prevalence rates are generally higher in girls and increase with age across most pain diagnoses [1], with peak prevalence rates among adolescent females ages 14–16 years [4].

• Contributing factors

The complexity of the chronic pain experience in childhood is best understood through a biopsychosocial model, which considers the numerous physiological, psychological, and social factors that influence pain and disability [5]. Specific parameters contributing to the maintenance and exacerbation of the pain experience include pain severity [6,7]; general cognitive/affective factors such as anxiety [8] and depression [9,10]; and pain-specific cognitive/affective factors such as pain catastrophizing [11,12] and pain-related fear [13,14]. Beyond the biological, emotional and cognitive aspects that contribute to the pain experience, individual behavioral responses, such as coping strategies [15,16] and taking a self-management approach to pain [17] can significantly influence how a patient deals with their pain condition. Lastly, children and adolescents with persistent pain problems live within a social context that can impact outcomes in many ways, including parent responses [18–20] and peer influences [21].

• Impact

Chronic pain in childhood can affect activities of daily living [22], emotional well-being [11,23], school performance and attendance [24,25], sleep and physiology [26], and family [27] and social functioning [28], as well as lead to draining economic impacts [29].

• Prognosis

Few studies have examined how pediatric patients with persistent pain fare into adulthood. One study followed 76 pronounced pediatric migraine patients for 40 years and found that

at over half continued to have migraine attacks at 50 years of age or older [30]. Multiple studies have examined the long-term consequences of experiencing functional abdominal pain (FAP) in childhood. Children with FAP have a heightened risk for psychiatric comorbidity [31,32] and chronic pain in adulthood [33]. Walker and colleagues studied 843 FAP patients and with cluster analysis identified subgroups at initial evaluation based on profiles of pain severity, gastrointestinal and nongastrointestinal symptoms, pain threat appraisal, pain coping efficacy, catastrophizing, negative affect and activity impairment. The authors identified three profiles of functional abdominal pain patients: high pain dysfunctional, high pain adaptive and low pain adaptive. After controlling for age and sex, pediatric patients with the high pain dysfunctional profile were significantly more likely at long-term follow-up (9 years later) to meet criteria for a pain-related functional gastrointestinal disorder (FGID), FGID with comorbid nonabdominal chronic pain and FGID with a comorbid anxiety or depressive psychiatric disorder. Although high pain adaptive patients had comparable levels of pain severity with the high pain dysfunctional patients at the initial evaluation, their outcomes were as favorable as the low pain adaptive patients [34]. Lastly, Walker's work suggests that women with a history of FAP in childhood (resolved or unresolved in adulthood) show signs of central sensitization through increased wind-up (temporal summation) to heat pain compared with their healthy counterparts [35].

Few studies have examined the long-term outcomes of children who suffer from pain conditions beyond FAP. One recent study examined the physical and psychosocial outcomes of adolescents with juvenile-onset fibromyalgia in young adulthood (~6 years later) [36]. Patients with juvenile-onset fibromyalgia experienced more pain, poorer physical functioning, higher levels of anxiety and depressive symptoms and more medical visits compared with their healthy peers. The majority reported persistent fibromyalgia symptoms, with 51% meeting clinical criteria for the condition as an adult. A second study examined the quality of life among adults with childhood onset complex regional pain syndrome type I [37]. The authors found that, as a group, these individuals had poorer general health and physical functioning and 33% of the patients had experienced one or more relapse of

their symptoms. Collectively, treating complex pain problems in children and adolescents is of considerable importance in order to reduce the likelihood of its progression and comorbidity into adulthood.

Current state of psychological treatments

Psychological treatments for chronic pain in children and adolescents have generally focused on taking a self-management approach with a cognitive-behavioral focus [38], akin to the philosophy emphasized for adults with chronic pain [38]. Cognitive behavioral treatment of chronic pain typically involves one or more of the following components: psychoeducation; training in self-regulation of physiology; identification of maladaptive cognitions; behavioral exposure; and parent involvement. **Figure 1** depicts a schematic of current psychological treatments for children and adolescents with chronic pain.

• Psychoeducation

When providing the child and family with an explanation of chronic pain, the nonprotective nature of persistent pain signals being transmitted by the body and processed in the brain is emphasized and couched in a biopsychosocial framework [5]. Certain theories may be described depending on the focus of treatment, such as the Fear Avoidance Model of Chronic Pain [39], which conveys how heightened fear and continued avoidance lead to prolonged disability. The goal of psychoeducation is to provide a rationale for how psychological treatment can effectively address pain and restore function. Although it has not been examined as a stand-alone intervention, one randomized control trial (RCT) among adults with chronic pain found that education on pain neurophysiology resulted in improvements in pain cognitions and physical task performance, but did not improve levels of pain-related disability [40]. An additional theory, referred to as 'Explaining Pain' [41], draws on a range of educational interventions and conceptual change strategies to increase patient knowledge of pain-related biology. Explaining Pain advocates that shifting the conception of pain from a marker of damaged tissue to that of the perceived need to protect body tissue can promote reductions in pain and pain-related distress.

• Training in self-regulation of physiology

Skills taught within this domain include relaxation training [42], biofeedback [43], and

hypnosis [44]. These skills entail teaching youth to regulate aspects of their own physiology, including heart rate, breathing rate, skin temperature, muscle tension, etc.

• Progressive muscle relaxation

Progressive muscle relaxation is the most commonly used relaxation technique and can be therapist-, school nurse- or self-guided through the use of recordings. In a series of RCT for headache, therapist-assisted relaxation training was most effective for adolescents suffering from frequent tension-type headaches or migraines, with school nurse-administered relaxation training effective and most efficient for adolescents with tension-type headaches [45]. Additional commonly implemented relaxation techniques include diaphragmatic breathing and guided imagery. These skills provide children and adolescents with chronic pain a sense of control over an experience that is difficult to manage, which in turn combats feelings of helplessness in the face of pain.

• Biofeedback

In some cases relaxation skills are taught through biofeedback. This modality allows the patient to 'see' and 'listen' to their body's internal activities. This real-time feedback about physiological processes provides children and adolescents with concrete evidence of their pace and depth of breathing (respiration), muscle tension (muscle electromyography), sweat response (peripheral skin temperature) and/or heart rate (blood flow or heart rate variability). A recent retrospective review of 132 children referred to a biofeedback therapy clinic (who attended two or more biofeedback sessions for treatment of headache) found that overall headache days/week decreased from 3.5 to 2 post-treatment. Most episodic headache patients were responsive to treatment (73%), with almost half (48%) of chronic headache patients classified as treatment responders. Treatment responsiveness was associated with the patient's ability to raise their hand temperature >3 degrees at the last visit, indicative of the patient's ability to self-regulate their physiology, and the use of selective serotonin reuptake inhibitors, whereas preventative medication use was associated with nonresponse [46]. It is not clear why selective serotonin reuptake inhibitor use was associated with treatment response and warrants further study.

Figure 1. Current state of psychological treatments for children and adolescents with chronic pain. With greater recognition of the importance of influence of parents on treatment success, parents are integral across treatment modalities. Left to right reflects the evolution of treatment approaches, with psychoeducation a cornerstone of virtually all treatments. Early studies focused on self-regulation strategies, while work in the past decade focused on more comprehensive cognitive-behavioral packages that incorporate self-regulation and cognitive skills. Work published in the past 5 years incorporated behavioral exposure as either a component of a larger package or as the primary intervention.

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Altogether there is good evidence for the use of biofeedback, particularly with headache patients [47], but due to the need for specialized equipment and training, it is less commonly implemented. Interestingly, a recent pilot study that incorporated virtual reality and biofeedback for patients with chronic headache found promising results with improved pain, daily functioning and quality of life up to 3 months post-treatment [48]. Given that biofeedback can foster mind-body connections, decrease overall sympathetic arousal and enhance a child's sense of control, more research is needed to examine the mediating mechanisms that drive these improvements, particularly among other pain conditions beyond headache.

• Hypnosis

A related, yet somewhat misunderstood approach to physiological regulation and pain management is hypnosis. Hypnosis is often a clinician-trained and guided approach that aims to help children focus attention away from uncomfortable or distressing sensations and turn attention to an imaginative experience that is viewed as comforting, safe, fun or intriguing in order to enhance a child's sense of mastery [49]. It is most commonly used among children in acute painful settings to redirect attention, decrease distress, reframe painful experiences and help children dissociate from the pain [50]. This process typically involves three stages: induction (assisting

the child in dissociating from the environment); deepening the dissociation; and directing (e.g., offering a magic glove that reduces pain) or distancing (e.g., imagining going to a favorite place) suggestions to produce ‘hypnotic anesthesia’ or a place of safety. In the realm of chronic pain, this approach has gained momentum among children and adolescents with FAP and irritable bowel syndrome (IBS). In a systematic review of RCTs of gut-directed hypnotherapy in children with FAP or IBS, three trials were identified and all showed greater improvements in pain compared with standard care, with one trial demonstrating sustained improvement at 1-year follow-up [51]. In addition, a recent study observed comparable reductions in abdominal pain frequency and severity in patients using home-based hypnotherapy versus those receiving hypnotherapy by a therapist, suggesting the potential of this form of treatment as of lower cost and more directly available for a wider range of patients [52].

Recent innovative work with brain imaging has begun to demystify the underlying mechanisms associated with the effectiveness of hypnosis. In a study conducted with adult patients suffering from temporomandibular disorder, investigators identified hypnotic modulation of brain activity in response to noxious stimuli [53]. Another investigation found attenuated posterior insula response in adult IBS patients who responded to hypnosis treatment [54]. No research to date has examined the neuromodulatory mechanisms of hypnosis among children. Given that children have a greater tendency to become absorbed in their imagination, compared with adolescents and adults; they potentially stand to benefit more from these techniques. Accumulating evidence supports hypnosis in pain management and there has been a recent call to increase our use of this modality across all patients with chronic pain [55].

• Cognitive reappraisal/reframing

Identification of maladaptive cognitions with the aim of reappraisal/reframing [56] is often considered at the crux of cognitive-behavioral treatment. Children are often taught to identify their negative thoughts or ‘self-talk’; take on the role of detective to gather evidence for/against the thought or examine the likelihood that the negative outcome they expect may occur; and then modify these thoughts to attenuate their negative emotional response or change their

behavior. In many cases, this approach is augmented with the use of positive self-statements that emphasize one’s ability to cope effectively with a challenging situation (e.g., “I can do it!”).

In some instances patients struggle to change their thinking as it has become fused to their experience. In these cases, Acceptance and Commitment Therapy (ACT) is effective in addressing unhelpful thinking patterns. ACT shifts the focus from changing thinking to altering how a patient relates to their thinking [57]. In ACT, thoughts are conceptualized as dominating a patient’s experience and behavior choices. Thus, rather than aiming to change a patient’s thinking patterns, treatment focuses on changing the relationship with the distressing thoughts by creating distance between the individual and the thought, such as having a thought (“I am having the thought that my pain is unbearable”) versus believing a thought (“My pain is unbearable”; cognitive defusion [58]). Beyond cognitive defusion techniques, the predominant aim of ACT treatment is to address experiential avoidance through the use of behavioral exposure.

• Behavioral exposure

In the 1960s, William Fordyce was a pioneer in putting forth an operant learning model to understand the persistence of disability in patients with chronic pain [59]. Years later Vlaeyen and colleagues [60,61] developed graded *in vivo* exposure treatment that specifically targets fear of pain and disability through exposure therapy techniques, or repeated gradual approach toward activities previously avoided due to fear of pain or re-injury [62]. When safety behaviors are disassociated and the proceeding outcomes are not aversive, patients’ expectations are violated. Belief disconfirmation influences a correction of their fear expectancies, leading to extinction of fear and cognitive reappraisal [63–65]. A recent systematic review of exposure treatments for adults with chronic pain [66] concluded that graded *in vivo* exposure effectively reduces pain and fear-avoidance beliefs and behaviors. Although there is growing interest in the assessment of pain-related fear in children and adolescents [14] and application of the fear-avoidance model of pain among pediatric patients [67,68], no published trials of graded exposure in children exist.

Of interest, Wicksell and colleagues [69] conducted an RCT of a ten-session ACT-based treatment with exposure as the primary intervention in adolescents with chronic pain (i.e., headache,

musculoskeletal, neuropathic). The intervention led to greater reductions in pain, disability, pain-related discomfort and fear of pain compared with standard multidisciplinary treatment (including medication) for children with chronic pain. When they subsequently examined mediators of change, they found that the patient belief in their ability to function in the face of pain (referred to as psychological flexibility) and pain-related distress (pain reactivity) significantly predicted changes in pain-related impairment and depressive symptoms [70].

• Parent involvement

Parents are integral for successful treatment of chronic pain in childhood. Parents can serve as consultants, collaborators or co-clients [71]. As consultants, they provide important information on the historical and day-to-day context of the child's life. This is essential to identify accurate treatment goals and potential barriers to treatment. As collaborators, they can oversee the implementation of new skills. Last, they often serve as co-clients as they shift their understanding and responses from an acute (where frequent pain check-ins are important) to a chronic pain framework (where encouragement to function in the face of pain is preferred). Parent-specific treatment has typically focused on teaching operant techniques to guide parents in responding to their child's pain [72] or helping the child to manage and cope with pain [73,74]. Given the evidence that parents of children with chronic pain experience significant emotional distress in their own right [74–76], clinical interventions that target parents are needed. A group art therapy intervention for parents of children enrolled in an intensive pain rehabilitation program was recently implemented, with parents finding it helpful, supportive and validating of their experience of parenting a child with chronic pain [77]. A recent systematic review of parent–child interventions, including cognitive–behavioral and family therapy, in the context of child and adolescent, chronic illness could be beneficial in improving parent behavior and mental health, as well as child medical symptoms at post-treatment and follow-up [78].

• Current evidence for psychological treatment

Altogether, there is good evidence for psychological interventions for chronic pain in childhood. Fischer and colleagues conducted

a systematic review and meta-analysis of psychological treatments for the management of chronic pain in childhood through April 2013 [79], on the heels of a Cochrane review published in 2012 [80]. Across the 35 trials that met the rigorous inclusion criteria, virtually all favored the treatment arm on improving pain and disability, with the strongest evidence for the treatment of headache, due to the number of trials for this condition, compared with other pain conditions [79].

Emerging areas in the psychological treatment of chronic pain in childhood

• Emerging treatment methods

Group-based cognitive–behavioral therapy

Group-based cognitive–behavioral therapy (CBT) for children and adolescents with chronic pain has inherent benefits as the format promotes peer-support among children who often feel isolated and misunderstood. The benefits of the peer format can also extend to parents when groups run concurrently (e.g., [81]). Group-based CBT has demonstrated effectiveness for several pain-related problems such as inflammatory bowel disease [82], headache [83] and pain-related school absenteeism [84].

Internet-based cognitive–behavioral therapy

Although the group format is cost and time efficient, patients are often traveling a great distance to be evaluated and treated at a specialized pain clinic, with even greater difficulty accessing local psychological treatment for their chronic pain condition. Thus, internet-based CBT interventions for chronic pain have emerged. Clear advantages of this approach include the self-paced nature and lower risk of stigma [85,86]. Limitations to this method include the need for access to and comfort with technology and lack of immediate response to individual needs among unguided formats. A recent meta-analysis identified six randomized trials of interventions delivered over the internet for pediatric pain [85]. Effect sizes for internet-delivered CBT for pain were promising (ranging from 0.19 to 0.79), but generally below those found for internet-delivered CBT for anxiety and depression in children [85,87].

Palermo and colleagues developed one such program to deliver web-based family CBT to adolescents with chronic pain [88]. Adolescents receive pain education, relaxation training and other CBT skills, while parents receive

training on reinforcement of positive coping, reward systems, communication and modeling positive coping [88]. This intervention was associated with significant reductions in pain and activity limitations post-treatment compared with wait-list control group, with gains maintained at a 3-month follow-up [89]. Furthermore, Palermo and colleagues observed that pain and function changed concurrently throughout treatment, providing useful information for future psychosocial treatments [90]. Several internet-based CBT interventions for children with headaches have also demonstrated reductions in pain and in pain-related negative thinking [91,92]. A recently conducted systematic review demonstrated that remotely delivered psychological therapies have been beneficial in reducing pain intensity and severity in groups with headache and mixed pains at post-treatment [93]. Additionally, some researchers have recognized the need for remotely delivered self-management programs. During the recent development of an integrated web and phone-based self-management application, Stinson and colleagues explored the experiences and healthcare needs of pediatric pain patients, and these results showed considerable support for the program development [94]. It is likely that internet CBT is quite effective in some pain patients; although, there is a need to conduct more studies establishing this. However, complex patients with persistent pain-related disability likely need more intensive treatment.

Motivational interviewing

It has been determined that patient motivation, such as in altering coping behaviors, is a critical factor in successful pain management [95]. Research on the Pain Stages of Change Questionnaire, a measure adapted to assess readiness to change in adolescent patients and their parents, has demonstrated that a willingness to adopt a self-management approach to pain is correlated with better treatment outcomes [17,96]. Motivational interviewing, a patient-centered technique structured to produce movement toward change, has been successful in improving pediatric health behaviors, such as oral health, diet and physical activity [97]. Not surprisingly, motivational interviewing seems most effective when both parent and child participate in treatment [98]. More research is needed to determine if similar results are possible within the pediatric pain population.

Treatment of chronic pain & comorbid obesity

Childhood obesity rates have risen worldwide and are directly impacting pediatric chronic pain [99]. Bout-Tabaku and colleagues discovered that obese children, in general, show diminished function, reduced psychosocial health, lower physical fitness and more frequent reporting of pain as compared with healthy-weight peers [100]. Although much is unknown regarding the relationship between the two, research has found links between obesity and chronic pain syndromes, including abdominal pain [101], musculoskeletal pain [100,102] and headache [103]. Some studies identify that increased weight demonstrates risk of musculoskeletal system changes that negatively influence motor performance activities and lead to pain reporting [104,105]. As a result, quality of life can be affected [106]. Due to the potentially harmful compounding effects, it is critical that future research focuses on this topic to determine how to best treat pediatric patients with pain and comorbid obesity.

Intensive interdisciplinary treatment

Pediatric chronic pain programs, providing outpatient, inpatient and day hospital treatment, are dedicated to addressing the needs of children with chronic pain problems. Although there are currently 38 nationwide pediatric chronic pain programs that are growing rapidly in number as a result of positive treatment outcomes [107]. In one meta-analysis, multidisciplinary outpatient pain management clinics displayed superiority to no treatment, waiting list and single-discipline interventions (e.g., solely pharmacology or physical therapy) [108]. Flor and colleagues' results indicated that along with reductions in pain, patients receiving multidisciplinary treatment reported increases in mood and decreases in disability and healthcare utilization at both the end of treatment and follow-up time points. Similar positive results have been observed in pediatric multidisciplinary outpatient pain clinics with patients reporting significantly fewer doctor visits and decreased pain, somatic complaints and functional disability 3 months after their initial pain clinic evaluation [109]. However, adherence to treatment recommendations in a pediatric multidisciplinary outpatient pain clinic is often suboptimal. Specifically, almost a third of patients failed to initiate recommended changes in medication, slightly fewer never began new recommended physical therapy interventions, and approximately half of patients did not enter into recommended CBT.

For patients who continue to struggle with their pain symptoms and have difficulty engaging in recommended treatments, more intensive treatment approaches may be warranted. Eccleston and colleagues [110] put forth the first evidence to support intensive interdisciplinary pain treatment. After participation in a 3-week intensive program encompassing multidisciplinary treatment domains, a sample of 57 adolescents with chronic pain and their parents reported significant physical improvements at the end of treatment and 3-month follow-up. Additional improvements in anxiety and somatic symptoms were reported at 3-month follow-up. Parents reported significant improvements in their symptoms of anxiety, depression and stress post-treatment and these changes were maintained at 3-month follow-up. Additional support for intensive pain rehabilitation programs has emerged in recent years [111,112]. The only current randomized control trial of intensive rehabilitation demonstrated a larger percentage of patients in intensive treatment (55% of 52) improved compared with wait-list controls (14% of 52) [113]. Another investigation comparing outpatient multidisciplinary treatment with intensive rehabilitation found that although prior to treatment a comparable number of patients reported severe disability (62% of 50 for intensive rehab group, 52% of 50 for matched controls), significantly fewer patients in the intensive rehabilitation group reported high pain-related disability after treatment (2%) compared with their outpatient counterparts (38%) [114]. A recent systematic review and meta-analysis performed by Hechler and colleagues demonstrated preliminary evidence for positive effects of intensive interdisciplinary pain treatment. Overall, patients showed improvements in the domains of disability, pain intensity and depressive symptoms at post-treatment and short-term follow-up [115]. Despite the growing evidence to support these programs, there are currently very few in the world, likely owing to the costly nature from a hospital system and insurance perspective.

Where do we go from here?

- **Matching psychological treatment to presenting problem (disease vs psychological process)**

As we continue to build the evidence-base for the psychological treatment of chronic pain, more attention on matching treatment to the patient

is warranted [116]. Currently evaluations of psychological treatment almost universally focus on specific subgroups of pain patients, such as patients with fibromyalgia, abdominal pain or headache. This makes sense from a biomedical standpoint, but these diagnostic pain categories are not likely effective for distinguishing these patients psychologically. Children and adolescents with chronic pain may or may not have significant depressive symptoms, adjustment difficulties, anxiety, avoidance behaviors, fears about re-injury and other psychosocial risk factors. Grouping patients together by presenting pain complaint does little to uncover the psychological drivers that may impact recovery.

An emerging approach to better match patient to treatment involves using screening tools to stratify patients by risk of poor clinical outcome, such as the Keele STarT Back Screening Tool (SBST) [117] and the pediatric adaptation of this tool, the Pediatric Pain Screening Tool (PPST) [118]. Allocation to the high-risk group for both of these tools is driven by the tools' psychosocial variables. Using a stratified care treatment approach in adults with low back pain based on the SBST [117], patients reported greater improvements in general health and reductions in healthcare costs compared with current best practice [119]. Implementation of a stratified treatment approach among youth with chronic pain is still needed. Additionally, increasing our understanding of the patient phenotype to include any potential sensory abnormalities assessed via quantitative sensory testing [120] can potentially enhance the accuracy of treatments recommended.

Failure to consider individual patient characteristics can have real and immediate consequences in clinical treatment and reported outcomes in research trials. Within our current model of care, patients who are referred for psychological treatment of pain often progress through a series of trial-and-error attempts to determine what techniques are going to ultimately yield a positive result. Unfortunately, this can be quite discouraging to a patient with pain who may have already failed multiple other treatments before engaging in psychological services. In some cases, this trial-and-error pattern of care can result in early termination of therapy or a reluctance to return to treatment. Getting targeted psychological interventions in place early in the treatment of chronic pain in children is essential. With a growing literature that can identify specific pain-related mood,

cognitive and behavior patterns, we are poised to develop individually tailored treatments leading to improved long-term pain-related outcomes. The emergence of targeting pain-related fear in children is one example.

• Emerging treatment targets

Pain-related fear has been identified as an important contributor to pain-related outcomes in children. Pain-related fear has been associated with improvements in functional disability and depressive symptoms over the course of treatment [121], with higher levels of pain-related fear at the start of treatment associated with less improvement in functional disability and depressive symptoms. This suggests that patients who present with high levels of pain-related fear may benefit from psychological interventions that specifically target their fear response.

In addition to work in the area of pain-related fear, new work is emerging to target attentional biases in chronic pain [122] through mindfulness training [123] or attentional bias modification training (ABM) [124]. Besides its particularly appealing low cost and minimal effort training model, preliminary work with ABM provides evidence of therapeutic benefits, such as improvements in pain and emotional functioning, in adults with chronic pain [125]. A recent study with adolescents found that low levels of attention control were associated with increased attention bias for pain faces in combination with high pain catastrophizing, suggesting ABM's potential effectiveness in pediatric pain populations [126]. Further, work is underway to address important comorbidities among pain patients, such as sleep disturbance particularly involving cognitive-behavioral treatment for insomnia and sleep loss delivered in-person and online [127,128]. These approaches are just developing in the treatment of chronic pain among adults and have notable potential for applicability in children and adolescents.

Conclusion

To conclude, many children and adolescents face chronic pain in their lifetime. Evidence for the psychological treatment of persistent pain in childhood is strong and constantly evolving. Matching treatment to patient holds great promise as modes of delivery vary widely and can address a variety of important targets in varying intensity. It is an exciting time in the era of the development, implementation and evaluation of psychological treatment of chronic pain in childhood.

Future perspective

The evolving standard of care for pediatric chronic pain involves a multi- and often interdisciplinary treatment team. Options for biobehavioral treatment are expanding to be both face-to-face and remotely accessible, with increasing precision in targeting known psychosocial risk factors that impact recovery. Screening tools that stratify patients by psychosocial risk have the potential to be easily implemented in a busy clinic setting, arming providers with key clinical information to guide treatment decision-making. Last, movement toward 'big data' capture and analysis tools will aid the entire field in better defining drivers of pain dysfunction that go beyond our current diagnostic nomenclature.

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