Primary recurrent and chronic (daily) headaches, particularly migraine, tension-type (TTH), and mixed migraine-TTH, are common pain syndromes in children (the term will be used to include adolescents). A biopsychosocial multi-disciplinary approach, including psychological treatment, is considered essential for effective management. \cite{6,11} Maizels urges physicians to “stay aware” of behavioral research. \cite{12} Physicians caring for children with headache should be familiar with psychological interventions for this population to facilitate their provision. The principal aim of this paper is to describe the psychological interventions used in the treatment of pediatric headache.

Comorbid, precipitating and contributory psychological factors

Important factors that often contribute to the onset, maintenance, and exacerbation of pediatric headache include stress and psychiatric disorders, particularly anxiety and depression. \cite{6,13-20} Additionally, maltreatment in childhood has been associated with headache in adult life. \cite{21,22}

Neurobiological basis

The brain regions involved in the perception of and response to pain have been collectively termed the “pain matrix.” Readers
are directed to recent reviews.23-26 Detailed reiteration is not relevant to this paper, with the exception of two points: (a) The principal anatomic components of the “pain matrix” include the thalamus, insula, anterior cingulate gyrus (especially important), prefrontal cortex, primary and secondary somatosensory cortices, amygdala, periaqueductal gray matter, and cerebellum, and (b) with minor differences, the same network is involved in primary headaches.

The gate control and neuromatrix theories of pain highlight the seamless interaction between brain and spinal cord mechanisms in pain.27,28 These theories are supported by evidence such as the work of Goffaux and colleagues.29 Peripheral sensitization in headache can be considered an expression of such an interaction of sensory, cognitive, affective, and other inputs. The anterior cingulate cortex as well as the periaqueductal gray matter, and possibly other components of the “pain matrix,” are involved in the cognitive aspects of pain, and modulated by behavioural interventions.30 Brain and spinal mechanisms are involved in psychologically induced analgesia such as the placebo response, opioid and dopaminergic pathways being implicated.29,31-33

At a more abstract theoretical level, the cognitive processes of attention, expectancy and memory can help to understand how pain relief is accomplished by non-pharmacological methods. For example, clinical and experimental data in children with pain suggest that competing stimuli such as distraction and other psychological interventions consume attentional resources, making them less available for the painful experience (such as headache), with a consequent decrease in the perception of pain.34,35 The modulation of pain and distress through these cognitive processes likely involves brain and spinal mechanisms, as it does in adults, in keeping with gate control theory.

BIOPSYCHOSOCIAL FACTORS THAT CAN INFLUENCE TREATMENT

Predisposition To Headache

The following facts point to the possibility that a biological predisposition to pain36 may be responsible in part for headaches: (a) evidence of heritability;13,37,38 (b) large sex differences in prevalence;39 (c) increase in prevalence after puberty, particularly in females; and (d) strong associations found between headache and other pain syndromes such as functional abdominal pain40, and (e) between headache and psychiatric disorders such as anxiety and depression.37 Professionals must be sensitive to these considerations.

Developmental considerations

Assessment and management are influenced by the developmental level of the child (cognitive, psychosocial, dependence on guardians, ability to cooperate, self-report and consent). With the proviso that age is only a rough approximation of development, Andrasik et al41 suggest three age groupings, 1-6 years, 7-11 years and 12-18 years, over the course of which there is increasing developmental maturation, including the ability to engage actively in treatment. Active engagement is a prerequisite for most psychological treatments;42 however, many interventions can be adapted to preschool children and the cognitively challenged.9

Family and culture

Family related factors have a complex relationship with childhood headache: children learn to interpret and react to pain from family members.43 Primary headaches in children are frequently associated with a family history of headache in first degree relatives.6,20 Children of parents who have chronic headache show a greater somatic focus (concern about physical symptoms and health) than controls.44 The sex of both children and parents can influence parental reporting.45 Parental psychopathology may have an influence on headache and other illnesses in children.18 There is a relatively high incidence of psychiatric disorders in parents of children with headache, especially migraine, in clinic based studies.5,20 Such illnesses in family members are important stressors for children with headache.6 For all these reasons, assessment and treatment has to be both child and family-centered.

Cultural influences have not been well studied in headache,43 but influence management. Hence, conclusions should not be extrapolated to populations not represented in study samples.46

ASSESSMENT AND MEASUREMENT OF MULTIPLE HEADACHE-RELATED OUTCOMES

Headache has many facets, and needs to be assessed multi-dimensionally (e.g., symptoms, physical functioning, mental health, role functioning). Some important domains of assessment and some commonly used measures are listed in Table 1.47-67 In addition, primary headache disorders are often associated with stressors and with psychiatric disorders; hence, a multi-axial approach is ideal.5,68 Impact of headaches on everyday life has to be assessed in several domains (e.g., school, social, play, family, sleep). Pain severity in children is often assessed compositely on a numerical rating scale (0-10), a visual analog scale, or a faces scale, depending upon the child’s developmental level. The PEDMIDAS and the Pediatric Quality of Life Inventory have been field tested in migraine, and can be incorporated into everyday care.49,69 Universally accepted valid and reliable measures are needed to assess the impact of headache in children, for use both in treatment trials and clinical practice.70

PSYCHOLOGICAL INTERVENTIONS

Overview of psychological treatments for headache

Some of the commonly used methods in children are listed in Table 2.71-99 Psychological treatments for headache in children are derived from treatment of headache in adults,100,101 and from treatment of children with other forms of pain. These interventions are also used across a variety of mental health problems (e.g., anxiety, depression, substance abuse, etc.). Some of the commonly used methods in children are listed in Table 2. Most of these interventions, with the exception of specific types of biofeedback, are generic for all types of headache, migraine being the most studied.

Cognitive-behavioral therapy (CBT)

Cognitive-behavioral therapy is based on the premise that our thoughts dictate our feelings and behaviors and that we can alter these thought patterns in order to feel better.102 Treatment includes both cognitive and behavioral components. Cognitive
Table 1: Assessment and measurement of multiple headache related outcome domains

<table>
<thead>
<tr>
<th>Outcome domain</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain Intensity</td>
<td>• Numerical Rating Scale (better termed Verbal Numeric Scale)(^{47-51})</td>
</tr>
<tr>
<td></td>
<td>• Faces scales(^{52})</td>
</tr>
<tr>
<td></td>
<td>• Faces Pain Scale – Revised(^{53})</td>
</tr>
<tr>
<td>Pain Qualities (Sensory, Affective, Temporal)</td>
<td>• Adolescent Pediatric Pain Tool(^{54})</td>
</tr>
<tr>
<td>Functional Impairment</td>
<td>• Functional Disability Inventory(^{55,56})</td>
</tr>
<tr>
<td></td>
<td>• PROMIS Pediatric Pain Interference Scale(^{57})</td>
</tr>
<tr>
<td></td>
<td>• Child Activity Limitations Interview(^{58})</td>
</tr>
<tr>
<td></td>
<td>• PedMIDAS(^{59})</td>
</tr>
<tr>
<td>Quality of life</td>
<td>• Pediatric Quality of Life Inventory Version 4.0(^{60})</td>
</tr>
<tr>
<td></td>
<td>• Quality of Life Headache in Youth(^{61})</td>
</tr>
<tr>
<td>Social, Emotional, and Cognitive Outcomes</td>
<td>• Multidimensional Anxiety Scale for Children(^{62})</td>
</tr>
<tr>
<td></td>
<td>• Revised Children’s Manifest Anxiety Scale-2(^{63})</td>
</tr>
<tr>
<td></td>
<td>• Children’s Somatization Inventory(^{64})</td>
</tr>
<tr>
<td></td>
<td>• Pain Catastrophizing Scale - Child(^{65})</td>
</tr>
<tr>
<td></td>
<td>• Pediatric Fear of Pain Questionnaire(^{66})</td>
</tr>
<tr>
<td></td>
<td>• Pediatric Pain Fear Scale(^{67})</td>
</tr>
</tbody>
</table>

Table 2: Overview of psychological interventions for pediatric headache and level of evidence for their efficacy

<table>
<thead>
<tr>
<th>Evidence Level</th>
<th>Intervention</th>
<th>Components of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence-based treatments (supported by multiple RCTs)</td>
<td>Cognitive-behavioral therapy(^{71,71-74})</td>
<td>• Psychoeducation about pain(^{75})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Distraction(^{76})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reinforcement(^{75})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Behavioral Activation(^{75})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Activity Pacing(^{7,78})</td>
</tr>
<tr>
<td></td>
<td>Relaxation therapy(^{79-81})</td>
<td>• Imagery(^{76})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Progressive Muscle Relaxation(^{7,83})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mindfulness Meditation(^{84})</td>
</tr>
<tr>
<td></td>
<td>Biofeedback treatment(^{85-87})</td>
<td>• Autogenic training(^{85})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Electromyography(^{86-91})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Thermal biofeedback(^{87})</td>
</tr>
<tr>
<td>Promising treatments (based on clinical reports, current clinical practice, or single RCTs without strong evidence)</td>
<td>ACT(^{92})</td>
<td>• ACT with mindfulness(^{93,94})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Values-based Assessment(^{95})</td>
</tr>
<tr>
<td></td>
<td>Hypnosis(^{96,97})</td>
<td>• Initiation of relaxation, imagery, suggestion, positive affirmation(^{98,99})</td>
</tr>
</tbody>
</table>

RCTs = Randomized Controlled Trials. ACT = Acceptance and Commitment Therapy
components include providing psychoeducation about the pain\textsuperscript{75} as well as teaching the child to reappraise the pain and to use self-instructions to promote coping. Additionally CBT teaches children to consciously plan to utilize coping and mood altering (e.g., smile to yourself) strategies in headache-producing situations\textsuperscript{103}

Imagery and distraction are two other common and supported cognitive techniques used in treating pediatric headache and often incorporated in CBT. Distraction techniques involve helping children identify areas other than the pain that they can think about, while imagery utilizes visualization of the child’s favorite place or activity or other pain-altering experiences. An audio recording of guided imagery can be made or a generic one can be provided to a patient with the instruction to engage in daily practice\textsuperscript{76}

Behavioral interventions, including some that are brief and designed to be administered by neurologists, have been described\textsuperscript{104-106}. Behavioral interventions can be single-session\textsuperscript{105,106}, group-based\textsuperscript{107}, home-based\textsuperscript{104} and parent-mediated\textsuperscript{89}. Behavioral techniques that are helpful for youth with headaches include reinforcement, behavioral activation, activity pacing, and progressive muscle relaxation (PMR).

Differential reinforcement of non-pain behavior (e.g., attending school; completing activities of daily living; seeing friends; participating in extracurricular activities) is an effective technique to help restore and maintain functioning\textsuperscript{75}. Additionally, ignoring pain and avoidant behaviors associated with headaches (e.g., attention seeking for pain) is also helpful in order to promote functioning. Helping caregivers and teachers learn to provide positive reinforcement either through praise or, depending on the developmental level of the child and level of impairment, through a reward (e.g., sticker earned toward a small prize for attending school the entire week) assists in promoting functioning. Along similar lines, behavioral activation, in which the child devises a list of values that (s)he finds rewarding and then creates goals to accomplish each week in accordance with these values, helps the patient to increase activity levels and prevent avoidance behaviors.

Patients with headache often have a pattern of avoidance and fatigue\textsuperscript{76} interspersed with spikes of overactivity. Activity pacing helps to establish more consistent, balanced levels of activity rather than alternating periods of inactivity with overactivity and exhaustion\textsuperscript{78}. Pacing helps patients to be in control of their headache by finding a realistic rate of activity that does not worsen pain\textsuperscript{108,109}. Specifically, activity pacing involves having the patient gradually re-integrate back into activities, including school, sports, and leisurely activities, while also getting appropriate rest. When introducing pacing, it is good to have the child start by keeping an activity diary every day for a week in order to ascertain the type, duration, and frequency of the activities he or she engages in or avoids, and the headache intensity associated with each pursuit\textsuperscript{109,110}. Then, a plan for gradual normalization can be developed. Specific pacing strategies that have been found helpful for patients with chronic pain include making a plan the night before for the next day, which includes realistic goals for activities and breaks for the following day\textsuperscript{77}. The key is to have a balance between activities and rest, and ensure realistic expectations.

Relaxation can be cognitively based (e.g., distraction, imagery), and can also involve behavioral components. Progressive muscle relaxation, a type of behavioral relaxation practice that involves tensing and relaxing each muscle group in order to learn the difference between feeling tense and feeling relaxed, has been widely used in the treatment of pediatric headache\textsuperscript{92,93}. Typically, while engaging in diaphragmatic breathing (i.e., deep belly breathing), a muscle group (e.g., hands, feet, head, stomach, etc.) is tensed for 5-10 seconds and then relaxed for 10-20 seconds. Progressive muscle relaxation can be used in conjunction with guided imagery and as with guided imagery, can be taught to the child through the use of a guided exercise, then the child can practice at home with an audio recording such as a compact disc. While PMR is highly effective in pain management, the tensing component is best avoided in body areas where there is musculoskeletal dysfunction, as contracting muscles sometimes leads to cramping and can exacerbate pain\textsuperscript{111}.

Biofeedback

Biofeedback helps patients to improve their self-regulation of pain-related physiological processes by providing direct measurement and feedback of parameters such as muscle tension via electromyography, heart rate and heart rate variability, respiration rate, or skin temperature. Electromyography (EMG) focuses on monitoring the electrical activity of the skeletal muscles and helps to increase self-control of muscle tension\textsuperscript{88,90,91,112}. Thermal biofeedback, typically recommended for migraine, involves placing temperature sensors (thermistors) on the forehead and the periphery (e.g., fingertips); audio or video signals provided via a computer help the patient to learn to reduce the temperature of the forehead and increase the temperature of the periphery\textsuperscript{87}.

Hypnosis and training in self-hypnosis

Hypnosis is based on the premise that a deep state of relaxation and decreased peripheral awareness can lessen the strength of pain signals\textsuperscript{96,97,113}. Children more readily engage with hypnotherapy than adults.\textsuperscript{98} Specifically, children as young as five can be hypnotized, with hypnotic ability peaking between the ages of 7 and 14 years\textsuperscript{114}. The hypnotic process includes: (a) assessment of hypnotic ability, (b) an induction phase if necessary, which may include the development of individual pain management strategies, (c) suggestion, which utilizes imagery of favorite and safe places as well as metaphors, and (d) termination phase.\textsuperscript{98} Self-hypnosis, incorporating positive affirmation statements and self-suggestions, has also been found to be effective in managing headaches in children\textsuperscript{99}.

Mindfulness meditation

Mindfulness meditation is based on the premise of remaining in the moment and not worrying or focusing on the past or future. Patients are taught structured exercises to help them notice their momentary changes in thoughts and sensations while maintaining an attitude of detachment or neutral interest rather than emotional involvement. Mindfulness differs from CBT, as it stresses that “we cannot change the thoughts that come into our head”; however, we can change whether and how we pay
attention to these thoughts and can also change our responses and actions to our thoughts.\textsuperscript{84} Mindfulness exercises typically focus on breathing calmly and allowing thoughts, feelings, and sensations to come and go without paying attention to them.\textsuperscript{84} Some younger children may benefit from placing a candy in their mouth and using all of their senses to focus on the taste, texture, and feeling of the candy while ignoring all other sensations.

**Acceptance-based treatments**

Acceptance-based approaches to pain management posit that acceptance rather than avoidance of pain of pain can result in a decrease of pain and disability.\textsuperscript{93,94} Acceptance and commitment therapy (ACT), one type of acceptance-based approach, has been used for the treatment of chronic pain in children and adolescents.\textsuperscript{115} Acceptance and commitment therapy utilizes mindfulness and values clarification to enhance psychological flexibility and help target avoidance-based behavior that can interfere with quality of life and values-based living.\textsuperscript{95} In this way, ACT differs from other behavioral pain management strategies in that symptom reduction is not the end goal; instead, the goal is to live one’s life in accordance with one’s values, while giving pain less prominence and control. This approach may be particularly useful for children who have received multiple interventions without benefit.

**Parent and family education**

Parents are essential participants in the management of headache in their children as parental attitudes, responses, and beliefs can influence pain and adherence to treatment.\textsuperscript{116-118} Specific parental interventions include helping parents understand the biopsychosocial factors that influence headache, as well as learn how they can support their child to manage and cope with symptoms. Additionally, parents can be taught to modify their response, so that pain behaviors are not reinforced.\textsuperscript{119} The neurobiological basis for headache, psychiatric disorders, and psychological treatments should be discussed with children, caregivers and teachers.

**Consultation with school**

Children with headaches frequently miss school\textsuperscript{120,121} so there is a need to interact with school personnel for several reasons: (a) to obtain information about the child’s academic functioning, behavior, social interactions, bullying and peer relationships; (b) to share information about the child’s headache disorder; (c) to assist in improving attendance and maintaining progress with studies (home schooling may be needed for a short duration in some children with severe recurrent or chronic daily headache); (d) to develop a plan for gradual reintegration to academic and extra-curricular activities if there has been absence, and (e) in some cases, to provide treatment at school.\textsuperscript{120} Thus, teachers are key partners in management.

**Prevention**

Discussions must address future high-risk social and environmental situations for headache recurrence (e.g., studying for exams, college applications, participating in competitive sports), and provide preventive problem-solving strategies to deal with these situations.\textsuperscript{122}

**Evidence for Efficacy and Effectiveness**

A Cochrane review found strong evidence for the efficacy of psychological treatment in headache pain reduction as an outcome of (a) CBT, (b) relaxation training, and (c) biofeedback treatment.\textsuperscript{123,124} There was a six-fold higher probability of clinically significant improvement in headache with psychological treatment compared to control conditions. Similar conclusions were reached in an earlier meta-analysis.\textsuperscript{46}

Limitations of the studies to date include: (a) sample sizes, even in meta-analyses, are small; (b) most studies have not stratified patients as to headache type; (c) International Headache Society definitions and classifications are not often used; (d) most studies do not assess the effects of treatment over the long term; (e) evidence for outcomes other than pain is lacking; (f) studies concerning effectiveness (which refers to treatment response in clinical practice with less highly selected patients and less assurance of uniformity of treatment in comparison with efficacy trials) are lacking;\textsuperscript{125} (g) adequately controlled comparisons of psychological treatment separately and in combination with pharmacological treatment have not been done; (h) several of the treatment approaches described in clinical reports have not been evaluated in controlled trials (see Table 2); and (h) there is a limited use of control conditions other than waiting list, and very few studies incorporate the natural history of headache. Penzien and associates\textsuperscript{126,127} address some of these limitations and offer guidelines for future trials.

**Placebo effect and efficacy trials**

Placebo randomized controlled clinical trials have become the gold standard for assessing the efficacy of drugs, based on the now erroneous assumption that an inert (pharmacological) substance would have no clinical effect. Clinical observations over the past fifty years have shown that not only can considerable benefit be seen in the placebo-controlled arm of trials but adverse effects (“nocebo”) may also be reported.\textsuperscript{128,129} A relatively high percentage of subjects with headache treated with placebo show a therapeutic response, children more so than adults.\textsuperscript{128,130} The psychoneurobiological basis for the placebo response is now well established; further discussion is beyond the scope of this review and readers are directed to the cited references.\textsuperscript{31,32,128,131} There is no counterpart to the inert pharmaceutical agent in psychological research; even an apparently non-therapeutic interaction is not psychologically inert. “Pseudo therapy” such as sham biofeedback treatment to control for nonspecific elements of the therapeutic intervention may be appropriate in some situations.\textsuperscript{126,132}

**Challenges**

Challenges in promoting integration of psychological treatments into routine headache care include difficulty in accessing psychological service due to limited availability, distance, and cost, as well as poor adherence to appointments and treatment recommendations.

Few patients live close to qualified pediatric psychologists who are for the most part located only in tertiary institutions in major urban centres. In Canada, psychologists’ services are not covered by provincial health care plans. Some centres have free-of-charge outpatient programs in children’s hospitals, and mental
health clinics in the community. Such services often have long wait lists. Distance treatment could potentially improve access to those remote from facilities. Distance treatment refers to treatment administered (following an initial office visit) with the patient at home or in the local health facility, using mail, Internet, telehealth and other communication methods. Distance psychological treatment has been provided to children and adolescents suffering recurrent headaches through (a) manuals and regular phone contact, (b) the Web, (c) CD-ROM, and (d) smartphones. In Alberta, Canada, multidisciplinary group treatment, based in a children’s hospital, is offered via telehealth to adolescents with chronic pain including headache; patients attend at their local high schools. Distance treatment has so much efficacy as traditional face-to-face treatment, and is significantly more cost-efficient. Effectiveness of distance treatment when implemented in the community has not yet been assessed.

Adherence to appointments and treatment has not been well studied in pediatric headache. The rate of adherence for adolescents with chronic illness is about 50%. Barriers to adherence include scheduling issues, forgetting, distraction, attempts to be normal, medication side effects, and negative attitudes about psychological treatment. Interventions such as appointment reminders, providing information about the benefits of adherence, self-monitoring, problem-solving, reinforcing adherence with rewards, contingency contracting, and goal setting can be helpful.

**Conclusion**

Biobehavioral management is an essential pillar of pediatric headache management. Several principles of which can be integrated into clinical practice. There is strong evidence for the efficacy of cognitive behavioral therapy, relaxation treatment, and biofeedback in reducing headache pain. As in adults, psychological therapies should be discussed with families of all children with headache as an option or complementary to pharmacological management, especially in the following situations: patients with frequent headache; chronic daily headache with high risk factors for persistence; significant stressors; associated psychiatric disorders; overuse of medication, and intolerance to or lack of benefit from appropriate drugs.

"Integrated" (multidisciplinary, biopsychosocial) care, with neurologists, psychologists, psychiatrists and other professionals (as considered necessary), is becoming the standard of practice in many adult headache clinics. The European model has been shown to improve outcome and reduce costs. Multi-disciplinary headache programs for adults have been shown to be possible and effective in Alberta, Canada. A similar approach was found feasible for children in Saskatchewan, psychological services being made available without cost to the family. Integrated care for children with headache is attainable.

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**Notes**

(i) Searches for this review were carried out on PubMed and Psychnfo. They were based on search terms related to psychological treatment and headache, limited to the 0-18 age group. Additional searches were made using the names of psychologists known to have contributed to headache treatment research, especially pediatric headache, and using cited reference searches on Web of Science to identify recent papers that cited important earlier works.

(ii) Psychological interventions are generally provided by clinical psychologists, and by psychiatrists trained in them. Some interventions can be provided by family physicians, neurologists, nurses, social workers, biofeedback technicians, and other counselors as long as they have suitable training and resources.

(iii) Some of the descriptions of psychological treatments cite articles on chronic or recurrent pain rather than specifically headache. These are relevant because headache is the most frequent type of chronic or recurrent pain affecting children, and the same treatment methods generally apply to headache and non-headache pain.

(iv) Given the differences in funding for health care, professionals in each country need to determine how cost-effective integrated pediatric headache care can be achieved for their respective populations.

(v) SSS and CLvB contributed substantially to the concept and writing, mentoring CBS and AH through the process.

**References**

26. Sprenger T, Goadsby PJ. What has functional neuroimaging done


12. Maizels M. Why should physicians care about behavioral research?

2005 May;45(5):411-3.


