REVIEW AGGRESSIVE BEHAVIOR

Review: Evidence-Based Psychosocial Treatments for Childhood Irritability and Aggressive Behavior

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Objective: Irritability and aggression are among the most common reasons that children are referred to outpatient mental health services and represent symptoms of several child psychiatric disorders. Over the past 40 years, several types of psychosocial interventions have been developed to treat these problems. This review examines well-established interventions for childhood irritability and aggression as well as newer interventions with a growing evidence base.

Method: This is a narrative review of evidence-based psychosocial treatments for childhood irritability and maladaptive aggression highlighting the key principles, techniques, and assessment tools as relevant to clinical practice.

Results: Parent management training and cognitive-behavioral therapy both have extensive evidence bases and are recognized as efficacious interventions for childhood aggression and disruptive behavior. There is also accumulating evidence that these modalities as well as dialectical behavior therapy can be helpful for irritability in the context of severe mood dysregulation and disruptive mood dysregulation disorder. Technology-based and telehealth interventions for childhood aggression and irritability show promising results and potential to improve access to services. Lastly, measurement-based care, while still a developing area in child mental health, may provide a promising addition to enhancing the efficacy and precision of psychosocial treatments of childhood aggression and irritability.

Conclusion: Parent- and child-focused psychosocial interventions such as parent management training, cognitive-behavioral therapy, and their combination can be helpful for the reduction of irritability and aggression. Well-powered randomized controlled trials with outcome measures that reflect current conceptualization of maladaptive aggression and irritability are needed to extend this evidence base to older adolescents and to examine the role of co-occurring psychopathology in treatment response.

Plain language summary: Childhood irritability, excessive anger, and aggressive behavior are among the most common reasons that children are referred to mental health services. This narrative review discusses psychosocial interventions that have been shown to improve these emotional and behavioral symptoms through rigorous clinical research. In addition to a practical discussion of psychotherapeutic techniques for working with children presenting with irritability and aggressive behavior, the authors review innovative approaches and identify areas for future research.

Key words: aggression; evidence-based; irritability; psychosocial treatment

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Childhood irritability and related aggressive behavior constitute one of the most common reasons that children are referred to outpatient mental health services.[1] Irritability, defined as a reduced threshold for experiencing anger, captures a wide range of affective and behavioral phenomena, ranging from annoyance and angry mood to temper outbursts and reactive aggression.[2] Aggression, or behavior that poses risk of harm to self or others, is particularly problematic when it takes the form of maladaptive aggression, in which the harmful behavior is not warranted by or disproportionate to the current context.[3] There is considerable overlap in the constructs of irritability and aggression in the literature with the emerging consensus that the term irritability reflects emotional reaction and the term aggression reflects behavioral response to frustration or provocation.[4] Both irritability and maladaptive aggression exist across a range of childhood mental health disorders, with irritability serving as a core feature of disruptive mood dysregulation disorder (DMDD), oppositional defiant disorder (ODD), and major depressive disorder and maladaptive aggression serving as a core feature of conduct disorder (CD) and intermittent explosive disorder in *DSM-5-TR*.[5] Although aggressive behavior may confer different meanings in different contexts and different classifications of aggressive behavior exist and continue to evolve in the literature,[6,7] this review focuses on maladaptive aggression that occurs in the context of developmental psychopathology and emotion dysregulation. For brevity, going forward we will use the term aggression to refer to maladaptive aggression.

Childhood aggressive behaviors are associated with poor clinical outcomes and constitute a significant public health burden. Regarding prevalence estimates over development,

approximately 5% of children and adolescents 6 to 15 years old in community samples display significant aggressive behavior that remains stable from childhood to adolescence. Average prevalence rates of CD are 3% across epidemiological studies.[8] Societal cost of childhood aggression and CD is staggering with an estimated 5.75 million years lived with disability globally.[9] The cost of public health care and educational services in adolescence was $70,000 more for children identified as aggressive in kindergarten than for nonaggressive children.[10] Of children with persistent aggression trajectory, 50% exhibited high service use across health, justice, and social welfare domains at age 38 years.[11] Consequently, prevention and treatment of childhood aggression is an important public health priority. The urgency of the issue is underscored by reports that nearly half of children with a mental health disorder in the United States do not receive any treatment,[12] and only 60% of children with a primary diagnosis of disruptive behavior disorders receive an evidence-based intervention.[13] This review provides a summary of clinically relevant evidence bases and an update on new developments in psychosocial treatments for childhood irritability and aggression.

METHOD

In the past 40 years, several types of psychosocial interventions have been developed to treat excessive anger and temper outbursts, the constructs that have become central to the syndrome of severe irritability during the past decade. This review highlights interventions that have received extensive empirical support including parent management training (PMT) and cognitive-behavioral therapy (CBT). Adaptation of child-focused interventions such as dialectal behavior therapy (DBT) for children with severe irritability is also discussed. Next, technology-based delivery approaches, including digital PMT, telehealth, and interpretation bias training (IBT), are reviewed. Lastly, measurement-based care (MBC) is discussed with a focus on the application of MBC to the treatment of childhood irritability and aggression. When describing established psychosocial interventions, we prioritized referencing randomized controlled trials with larger samples and existing meta-analyses. We also conducted a literature search using PubMed and Scopus to locate randomized controlled trials of psychosocial interventions reported during the past 10 years to identify novel and technology-based approaches described in this review.

RESULTS

Parent-Focused Interventions

PMT is one of the most well-known interventions for behavioral and emotional problems in children and one that has received the highest levels of empirical support.[14] PMT is conducted with the parent and focuses on teaching skills to parents with the goals of increasing positive parent–child interactions, increasing child compliance with parental demands, and decreasing child anger outbursts and aggressive behavior. Theoretical underpinnings of PMT include operant conditioning, which postulates that the likelihood of behavior to recur is increased or weakened based on the events that follow this behavior,[15] and the social learning model of escape/avoidance conditioning of disruptive behavior.[16] For example, a child is more likely to have another tantrum if previous anger outbursts have resulted in an escape from parental demands or the continuation of a preferred activity. Thus, the function of maladaptive aggression in parent–child interaction (ie, why did the behavior occur) can include escape or avoidance of demands (eg, starting homework) or access to preferred activities (eg, watching YouTube). Receiving attention from parents for aggressive behaviors is also a powerful reinforcer of these behaviors. At the outset of PMT, parents are asked to focus on observable behaviors (eg, noncompliance, yelling, hitting) and taught to identify antecedents and consequences that might be contributing to and/or maintaining the problem behavior. Parents are also educated about the cycles of escalating coercive behaviors (eg, child throws a tantrum, parent scolds, tantrum escalates, parent gives in) that mutually reinforce each other and increase the hostility of parent–child interactions over time[16] and learn to identify if they might be inadvertently reinforcing their child's problem behaviors through similar patterns. During PMT, a key focus is on positive reinforcement for desired, appropriate behavior. Parents may be taught to label and attend to the positive opposites, or the behaviors they would like to see in place of the problem behavior.[17] Parents are taught to consistently reward positive opposites with attention and specific praise as well as how to supplement social reinforcement with tangible rewards, such as screen time or a points system. Other elements of PMT include teaching parents how to effectively communicate directions, ignore certain undesired behaviors, and consistently and effectively respond to problem behavior.

PMT has one of the largest evidence bases of any psychosocial intervention for children and has been evaluated in more than 100 randomized controlled studies.[18] Multiple named PMT programs exist, including the Oregon Social Learning Model,[19] Triple P-Positive Parenting Program (Triple P),[20] Incredible Years Program,[21] and Parent–Child Interaction Therapy,[22] and excellent PMT manuals are available for use in outpatient settings.[17,23]

Meta-analyses of PMT demonstrated its efficacy in reducing aggressive behaviors with the magnitude of effect

TABLE 1 Key Principles and Practices of Parent Management Training (PMT) and Cognitive-Behavioral Therapy (CBT) Interventions Summarized Across Represented Treatment Manuals

Key topics and practices of PMT	
The ABCs of behavior	Parents are helped to define presenting concerns in specific behavioral terms and to identify and monitor events that precede and follow this behavior
Differential attention	Ignoring minor misbehavior such as whining and paying attention to the child when they engage in desired behavior such as starting homework on time
Effective commands	Giving fewer but more specific requests that reflect realistic expectations, using clear and simple instructions, using neutral tone of voice with encouraging nonverbal cues, and following up with reminders as needed
Praise and rewards	Identify positive opposites of behavioral problems and learn to provide consistent and contingent social and tangible rewards
Daily routines	Develop consistent daily routines to reduce unexpected transitions or disagreements about topics such as bedtime or allowed amount of screen time
Parent–child relationship	Plan and implement enjoyable parent–child activities such as child-guided play with young children and sharing in interests (eg, sports, video games) with adolescents
Key topics and practices of CBT child-focused interventions	
Education about anger and related emotions	Validation and normalization of anger as an emotional experience in response to frustration or provocation and learning about the sequence of triggers, experiences, expression, and outcomes of anger episodes
Practicing emotion regulation skills	Learning about cognitive and behavioral strategies for reducing excessive anger experience and inappropriate anger expression
Problems identification and attribution	Recognizing how emotions can signal that something is a problem and learning to consider the perspective of other people involved in the problem situation
Solutions and consequences	Generating alternative solutions to problem situations and considering consequences of each solution for self and others; appreciating effects of emotional arousal on problem solving
Coping with peer provocation	Developing assertive responses to provocation by peers and siblings; practicing verbal strategies that respect the rights of others and de-escalate potential confrontations
Parent–child communication	Practicing communication strategies that can prevent or reduce the frequency and intensity of arguments and conflicts with parents

sizes ranging from 0.45 to 1.08.[18,24,25] Studies have also demonstrated the effectiveness of PMT in real-world settings,[26] its sustained effects over time,[27] and its utility in preventing the development of antisocial behavior in adulthood.[28,29] Importantly, most studies of PMT have been conducted in children identified with broadly defined aggressive behavior, and more research is needed to evaluate the use of PMT in children with high levels of irritability and mood dysregulation, such as is seen in DMDD.[30] Still, PMT has been consistently linked to the reduction of ODD symptoms, which includes symptoms of irritability as well as symptoms of argumentative, defiant, and vindictive behavior. In fact, in one study of PMT for young children with ODD, children with more irritable ODD symptoms showed greater reductions in behavior problems relative to children with more headstrong ODD symptoms,[28] indicating that PMT can be particularly effective for children with high levels of irritability who may have greater susceptibility to the caregiving environment. Key principles of PMT interventions summarized across representative treatment manuals are shown in Table 1.

In addition to the emphasis on social learning and coercive family processes, which form the theoretical basis of PMT, there has been increased focus in recent years on the role of parental socialization of emotions and its associations with child irritability and disruptive behaviors.[31,32] Several randomized controlled trials demonstrated positive effects of emotion-focused parenting programs on the reduction of childhood behavior problems, including in toddlers,[33] preschool children,[34] and school-age children.[35] The intervention uses emotional couching to strengthen the emotional connection between parents and children and to enhance the parents' awareness of their child's emotions while teaching safe expression of anger. Notably, in a randomized comparison trial, an emotion-focused and behavior-focused parent training program (Triple P) demonstrated comparable efficacy in reducing behavior problems in young children.[36]

Another parenting intervention that departs from the more traditional model of PMT is Collaborative & Proactive Solutions (CPS). While CPS is partially founded in social learning theory, its framework has also been informed by research on skill deficits in children with emotional and behavior difficulties.[37] The CPS model postulates that temper outbursts and verbal or physical aggression can occur when a child is faced with expectations for which they do not have the skills to be successful. To address this issue, the CPS model consists of 2 main steps: helping parents to identify a child's areas of skill deficit and problem areas and helping parents engage with their child to solve the problems collaboratively. The efficacy of CPS for children with ODD has been evaluated and compared with PMT in 3 randomized comparison trials,[38–40] with results demonstrating positive and comparable effects of the 2 interventions.

Child-Focused Interventions

CBT for irritability and aggression, similar to other forms of CBT, focuses on helping children identify and change unhelpful patterns of feelings, thoughts, and behavior,[41] with a specific emphasis on emotion regulation and problem solving.[42] In particular, CBT for irritability and aggression focuses on helping children to better understand and recognize their experiences of anger and frustration, helping children to learn and use strategies for regulating their emotions, and helping children to develop and use problem-solving and social skills to prevent and/or manage anger-provoking situations in socially appropriate ways.[43] CBT is conducted primarily with the child, although parents can be involved in treatment in multiple ways, such as by providing information about their child's behavior at home and by helping to support their child's use of new strategies and skills in their everyday life.

Anger control training (ACT) is one version of CBT for irritability and aggression that focuses on helping children to modulate their experiences of anger and more adaptively respond to anger-provoking situations. During ACT, which often takes place in a group format, children are taught to recognize signs of anger arousal and use strategies such as relaxation, distraction, and cognitive reappraisal to manage anger and tolerate frustration. Different versions of ACT, including the Anger Coping Program and Coping Power Program,[44,45] have been evaluated in school-age children[46] and adolescents,[47,48] reporting reductions of anger and aggression with effect sizes ranging from 0.56 to 1.1.[49]

Problem-solving skills training (PSST) is another version of CBT for childhood aggression that was founded on research on problem solving in children[50] and social information processing theory.[51,52] Social information processing theory, which asserts that the way in which a person interprets a social situation influences how they will respond to it (eg, competently vs aggressively), specifies 5 stages of information processing: encoding of cues, interpretation of cues, generation of responses, evaluation of responses, and enactment of responses. Problems at any one of these stages can increase the likelihood of angry or aggressive responding.[53] During PSST, children are taught to carefully analyze social situations, generate nonaggressive solutions to interpersonal conflicts, consider the consequences of their actions, and practice carrying out nonaggressive solutions during interpersonal conflict. Several controlled studies have evaluated the use of PSST in children and adolescents, with results indicating positive effects on the reduction of aggression and improvements in social problem solving,[54,55] with effect sizes for reduction in aggressive behavior ranging from 0.50 to 0.86. Some evidence suggests that the effect of PSST on the reduction of aggressive behavior may be mediated through changes in social cognitive skills of children,[56,57] emphasizing the relevance of targeting these skills in treatment of aggressive behavior.

Although the relative efficacy of parent- and child-focused interventions has received considerable attention, it is also recognized that some combination of both approaches is likely to be the most practical strategy, at least in the settings where parents are expected to bring their children for treatment. Studies that directly compared child-focused treatment with combined child and parent–focused interventions demonstrated greater improvement in behavioral problems for combined treatments,[46,55,58] particularly in children with greater severity of disruptive behavior.[59] In clinical settings, the relative proportion of parent- vs child-focused treatment components may depend on child's age and engagement as well as on the availability and readiness of parents to participate.[60] There is also evidence that a combined CBT and parent management training program called Stop Now and Plan (SNAP), consisting of 12 weekly group sessions with children referred for conduct problems and their parents, was effective for reducing delinquent behavior and aggression. Of relevance to this review, SNAP has been evaluated in several clinical trials by 2 independent groups of investigators and used the Child Behavior Checklist (CBCL) aggression subscale as an outcome measure narrowly focused on aggressive behavior rather that broadly defined externalizing or disruptive behavior problems. The first randomized controlled trial in 30 children younger than age 12 years reported significant reduction in CBCL aggression scores after SNAP compared with the recreational activities program control condition (effect size $d = 0.79$).[61] The second, larger trial enrolled

252 children 6 to 11 years of age who were randomly assigned to SNAP or referred to standard clinical services.[62] Active treatment was significantly more effective in reduction of CBCL aggression subscale scores, although the effect size of 0.29 was smaller than in the first trial, possibly due to the use of a standard clinical care control condition.

Regarding structured manuals, several treatment manuals for conducting CBT for anger and aggression with children are available,[45,48] but most are intended for group administration in settings such as schools or inpatient facilities. The last author and colleagues, however, have developed a version of CBT intended for use in outpatient individual therapy.[43] This version of CBT materialized over the course of 3 randomized controlled trials, which demonstrated the efficacy of CBT in reducing aggression in school-age children with aggressive behavior[63,64] as well as in adolescents with Tourette's syndrome and disruptive behavior.[65] The manualized version of CBT that emerged from these studies[43] consists of a comprehensive treatment that includes 10 child sessions that aim to help children develop their abilities in the areas of emotion regulation, problem solving, and social skills. In addition to the social information processing theory of childhood aggression, this version of CBT incorporates the social constructivist view of anger, which considers anger to be based on the meaning people impose on frustrating events[66,67] as well as the state-trait anger experience and expression model that has identified anger control as a distinct dimension of the cognitive processing of frustration.[68] The treatment manual also includes 3 separate parent sessions that focus on gathering information from the parents regarding the child's behavior at home and teaching key parent training strategies, such as praise and positive reinforcement for desired behavior and planned ignoring for minor misbehaviors. Key principles of CBT interventions summarized across representative treatment manuals are shown in Table 1.

While most studies of child-focused psychosocial interventions have been conducted with children referred for disruptive behaviors, recent research indicates that child-focused therapy may be useful for children with chronic irritability. In one study of children with severe mood dysregulation (a research diagnosis precursor to DMDD) and attention-deficit/hyperactivity disorder (ADHD), children were randomly assigned to integrative therapy, consisting of 11 child sessions of group-based CBT and 11 parenting group sessions, or to community care.[69] At the end of treatment, children in the integrative therapy condition showed greater reductions in irritability, measured by a 3-item scale indexing irritability symptoms of ODD, compared with children in the community condition (between-group effect size = 0.48). Although more research evaluating the efficacy of CBT and other standard treatments for disruptive behavior in children with chronic and severe irritability is warranted, results of this study provide preliminary evidence that a combined CBT and parenting intervention may be useful for children for whom irritability is their primary symptom.

The Modular Approach to Treatment of Children with Anxiety, Depression, and Conduct Problems (MATCH)[70] was also examined in children with severe irritability and emotion dysregulation. Specifically, a secondary analysis of data from 174 children ages 7 to 13 who participated in a randomized trial of MATCH vs standard care and treatment-as-usual control conditions indicated that 81 of 174 participants had high levels of irritability associated with functional impairment. Irritably was measured by 3 items from the parent-rated CBCL scale: "tantrums or hot temper," "sudden mood changes," and "stubborn, sullen, or irritable." Using this 3-item measure, MATCH resulted in significant reduction of irritability relative to usual care in the subgroup of 81 children with an effect size of 0.60. Notably, there was no significant difference in change of irritability between the MATCH and the standard care condition, which consisted of a structured PMT protocol.[71] MATCH is a modular intervention that consists of procedures from CBT for anxiety and depression and parent training for conduct problems. It has been designed for diagnostically complex youth 7 to 13 years of age seeking outpatient mental health services. In contrast to most manualized psychotherapies that require a standard number of sessions focused on one clinical problem, MATCH provides guidelines for clinicians for selecting initial treatment focus on anxiety, depression, or conduct problems as well as switching the focus in mid-treatment based on change in symptoms.

Another approach integrated PMT with exposure-based, child-focused strategies as a targeted treatment for irritability.[72] The treatment involves in vivo exposure to stimuli that trigger irritability with the aim to reduce exaggerated emotional responses. This approach is based on the rationale that anger, similar to fear, is an acute, stimulus-driven emotional state and that gradual exposure to anger-provoking stimuli can increase the child's ability to tolerate frustration. A recent open study tested this treatment in 40 children 8 to 17 years of age meeting criteria for symptoms of DMDD, either chronically irritable mood or temper outbursts. Notably, this study used a new, Clinician-Rated Affective Reactivity Scale (CR-ARS), a 12-item measure of a narrowly defined irritability developed to measure frequency, intensity, and duration of irritability on a weekly basis, with a possible range of scores from 0 to 100.[73] Exposure-based treatment resulted in a 22.5%

reduction of CR-ARS score from the mean (SD) pretreatment score of 43.63 (17.43) to 36.11 (19.94) after treatment with a corresponding within-group effect size of $d = 0.40$.

DBT, which was originally developed for adults with borderline personality disorder,[74,75] is now a well-validated treatment approach used for a wide range of mental health difficulties involving emotion dysregulation. While DBT has many similarities to CBT and uses many cognitive-behavioral strategies, it additionally employs acceptance- and mindfulness-based techniques. Traditional DBT includes individual therapy, between-session phone coaching, and group-based skills training.[76] DBT has been evaluated in different patient populations, including in adolescents with disruptive behavior[77] and bipolar disorder.[78] Recently, DBT was also adapted for preadolescent children with DMDD.[79] In this version of DBT, adaptations included simplification of language and didactic materials, adding of child-friendly activities, and incorporation of new skills (eg, the Surfing Your Emotion skill, aimed at helping children tolerate an emotional experience by mindfully observing it). When evaluated in a randomized controlled trial in 7- to 12-year-old children with DMDD, the rate of positive response assessed by the Clinical Global Impressions improvement scale administered by blinded raters was 90.4% in DBT compared with 45.5% in the treatment-as-usual control condition.[79]

Because anger outbursts typically occur in interpersonal contexts, interpersonal psychotherapy for depressed adolescents has been adapted for youth with severe mood dysregulation and piloted in a randomized trial with 19 adolescents with DMDD.[80] Interpersonal psychotherapy, originally developed for treatment of depression[81] and based on the theoretical framework of adolescent development, is focused on issues such as changing authority in parent–child relationship during adolescence, dyadic interpersonal relationships, and peer pressure. It was modified to target DMDD symptoms by focusing on anger outbursts in important relationships, identifying specific problem areas linked to mood symptoms and working on family expectations and parent–child relationships to decrease aggressive outbursts. There was a significant reduction of irritability after interpersonal psychotherapy for mood and behavior dysregulation relative to the treatment-as-usual control condition on the parent-rated Affective Reactivity Index (ARI) with an effect size of 0.83.

Technology-Based Interventions

Recently, technology-based interventions for the treatment of irritability and aggression in children have received increasing attention, with much research dedicated to the development and evaluation of such interventions.[82,83] These interventions not only reflect societal changes toward higher rates of technology use, but also address the growing concern to improve access to mental health care services for children. Barriers to in-person mental health care services for children are plentiful and include high cost, distant location, inconvenience (eg, lack of transportation, families' busy schedules), stigma associated with receipt of mental health care services, and lack of sufficiently trained staff.[84,85] Technology-based interventions, such as programs delivered via the internet, provide the potential to offset some of these barriers by allowing families to receive the intervention in the their homes. In addition, self-directed interventions can offer increased efficiency and cost-effectiveness of delivery by circumventing the need for highly trained professionals to deliver the intervention.[86]

Although many types of interventions have the potential to be delivered via technology-based platforms, due to its extensive evidence base and structured format, PMT has emerged as a frontrunner in this area.[82] In the past 2 decades, dozens of technology-based versions of PMT have been developed and evaluated, with generally promising results.[83,87] Technology-based versions of PMT span a wide range, varying in terms of delivery platform, use of digital media, presentation of program content, and presence/absence of professional support. Many of the programs are delivered via the internet; however, others are delivered using downloadable videos, podcasts, mobile apps, and DVDs.[88] While some programs use mostly noninteractive content (eg, text, videos, animation, audio recordings), other programs pair noninteractive content with interactive components, such quizzes with feedback, online posts and discussion forums, and automatic reminders.[82] In addition, some programs use a purely self-directed format, while others combine self-directed components with support from professionals via phone calls, videoconferencing, or e-mail exchange, during which the family can receive tailored guidance and coaching.[82]

Many well-established versions of PMT have been adapted for technology-based delivery. The Triple P,[89] for example, has been modified into an online format. The program is administered via the internet and is self-directed; parents receive instruction on parenting skills such as descriptive praise and time-out. Central elements of the program's online format include video demonstrations of key parenting skills, personalized goal setting and feedback, interactive exercises, downloadable worksheets and podcasts, and an automated system of e-mails and text messages to remind parents to continue with the program. Evaluations of online Triple P have yielded promising results. In one randomized controlled trial, children whose

parents received online Triple P demonstrated greater improvements in behavior problems compared with children whose parents were in a treatment-as-usual condition.[89] In another study comparing the use of online Tripe P and the use of the Triple P self-help workbook for parents, receipt of both interventions was associated with significant and comparable levels of improvement in child disruptive behavior.[90] More recently, a shorter, low-intensity version of online Triple P was shown to be helpful in families of children with mild to moderate behavior problems.[91]

Four meta-analyses and systematic reviews have evaluated the efficacy of technology-based versions of PMT for disruptive behavior with effect sizes ranging from 0.32 to 0.44.[82,83,87,92] For example, the 2017 review included 14 technology-based parent training programs for children with disruptive behaviors, 12 of which were evaluated in randomized controlled trials.[82] Children in the studies ranged in age from 2 to 18 years, with most children between 3 and 9 years of age, and the majority of studies included children with clinically significant levels of disruptive behavior. The majority of the interventions included some interactive components, and although most were exclusively self-directed, 3 of the interventions supplemented their self-directed content with professional support via weekly or biweekly contacts with a therapist. Results indicated positive effects of the technology-based interventions on improvement in child behavior, with self-directed interventions for parents of younger children (average age <9 years) yielding medium to large effect sizes and self-directed interventions for parents of adolescents yielding small effect sizes.

The most recent systematic review of technology-based parent training interventions investigated 10 randomized controlled trials of online parenting programs.[87] Studies included children 2 to 12 years of age with clinical or subclinical levels of disruptive behavior disorders. Results indicated positive effects of the online programs, with 9 of the 10 studies reporting significant improvement in at least one measure of child behavior. In addition, maintenance of improvements in child behavior was reported at follow-up time points between 3 and 10 months after the intervention. In a recent noninferiority study, internet-delivered PMT was found to be as effective as in-person group PMT.[93]

One main concern regarding technology-based parenting interventions involves the lack of potential benefits afforded by contact with a clinician. It has been hypothesized that direct, face-to-face contact with a clinician might be needed for parents to properly learn and implement parenting strategies, especially in the context of challenging circumstances.[83] In addition, without regularly scheduled meetings with a clinician, parents who are completing an online program on their own time might be less likely to access the program consistently and/or complete it. In general, the average completion rate was 79% for technology-based parent training programs, which is comparable to that of face-to-face interventions.[82] Similarly, in 2 separate studies comparing face-to-face vs online versions of specific parenting programs, completion rates were the same for families in the face-to-face and online versions.[94,95]

To capitalize on benefits afforded by contact with a clinician, several technology-based parenting interventions include professional support, ranging from e-mail exchanges to bimonthly phone check-ins to weekly video calls with a clinician.[96,97] For example, Tantrum Tool, a digital parent program for preschool- and school-age children with disruptive behaviors, includes 8 modules of self-directed online content combined with 3 video calls with a clinician.[98] Of note, this study reported significant reduction of ODD symptoms and narrowly defined irritability measured by the parent-rated ARI.[99]

While a nascent area of study, research on technology-based parenting programs is promising, with average effect sizes in small to moderate ranges. There is also evidence of the effectiveness of online parenting interventions when implemented in real-world primary health care settings.[100] Important avenues for future research in this area include evaluating the use of technology-based parenting programs in culturally and socioeconomically diverse populations as well as further investigating the roles of different intervention components in the efficacy of these programs. In addition to the adaptation of psychosocial intervention into digital or online formats, another related trend in the last several years has been the shift toward telehealth, defined here as the remote and synchronous delivery of health and mental health care services via videoconferencing platforms.[101] To-date, 3 well-validated interventions for children with irritability and aggressive behavior have been adapted and evaluated for telehealth use: Parent–Child Interaction Therapy,[102] Triple P,[103] and Defiant Children.[104] Paralleling the unprecedented need and proliferation of telehealth services initiated by the onset of the COVID-19 pandemic, in the past few years there has been increased focus on the need and potential for internet-delivered therapy. Evaluations of telehealth-delivered parenting interventions have highlighted both the utility and the feasibility of delivering these treatments via telehealth, particularly during the midst of a public child mental health crisis.

Most technology-based interventions targeting child disruptive behavior have been developed for parent-focused delivery.[96,98] Only a handful of well-designed studies have

applied technology-based modalities to child-directed interventions. First, a hybrid format of a school-based aggression prevention program, Coping Power, with both in-person (ie, parent and child group sessions) and online (ie, web-based psychoeducation and skill practice) components was evaluated in 91 children ages 9 to 12 years who were referred by teachers for aggressive behavior.[105] Teacher ratings indicated small but significant effects of the hybrid Coping Power program relative to a no-treatment control condition on the prevention of conduct problems ($d = 0.29$), but not aggressive behavior ($d = 0.21$). Notably, use of the program's website by children, measured as time spent on the website and percentage of web-based activities completed, significantly and negatively correlated with conduct problems at end point controlling for conduct problems at baseline. Children also reported high levels of satisfaction with the program and rated the ease of access to the program website higher than their parents. This study supported the feasibility of incorporating web-based content into child-focused interventions for disruptive behavior, but raised questions about significance of effects on aggression relative to more broadly defined conduct problems.

A recent randomized controlled trial evaluated a computer-assisted child-focused treatment that consisted of 16 weekly sessions in which the child and the therapists viewed videos of problem situations and followed a computerized training guide to explore their thoughts, feelings, and reactions in portrayed situations.[106] The therapist assisted the child's advancement through the computer program and role-played appropriate responses to situations deemed most relevant to the child. In this trial, 100 children 6 to 12 years of age with diagnoses of ODD or CD and elevated levels of peer-directed aggression were randomly assigned to computer-assisted social skills training or to a resource-activation control condition. Computer-assisted social skills training resulted in a greater reduction of parent-rated aggression toward peers with a between-group effect size of 0.64. However, both treatment conditions produced significant but similar pre- to post-treatment reductions in teacher and clinician-rated symptoms of aggression toward adults and disruptive behavior symptoms. Notably, this study showed clinically significant reduction of a narrowly defined type of aggressive behavior—peer-directed aggression—rather than the broadly defined conduct or externalizing problems. This can inform a more targeted treatment approach for peer aggression in 6- to 12-year-old children.

Incorporating virtual reality in psychotherapy is a burgeoning direction of psychotherapy research,[107] and given high interest in technology among children, adding virtual reality to talk therapy has a potential to enhance engagement of youth in treatment. To this end, one study tested CBT for aggression enhanced via interactive virtual reality.[108] The study included 115 children in 8 to 13 years of age who were referred to outpatient treatment for aggressive behavior. Children were randomly assigned to 1 of 3 conditions: CBT with virtual reality (where children practiced dealing with challenging situations via interactive virtual reality), CBT with role-play practice, or a standard clinical care control condition. Outcome measures included parent ratings of the frequency of aggressive behavior and the CBCL aggressive behavior subscale collected before and after 12 weeks of treatment. Subjects in all treatment conditions showed significant reduction in CBCL aggression scores after treatment, but children in the CBT with virtual reality condition showed significantly greater reductions in parent-rated weekly frequency of aggression relative to the care-as-usual control condition (between-group effect size = 0.68). As expected, children who received CBT with virtual reality reported greater treatment engagement and appreciation compared with children in the other treatment conditions.

Another novel area of technology-based interventions for children with irritability is IBT.[109] IBT is founded in research linking hostile attribution bias, the tendency to interpret ambiguous social cues as hostile, to increased propensity toward anger and aggressive behavior.[110,111] Akin to computerized cognitive training interventions, in IBT, participants view on a computer screen a sequence of faces morphed on a continuum ranging in expression from clearly happy to clearly angry. During each IBT session, participants are instructed to rate the facial expressions as happy or angry over 180 trials and receive feedback that is geared toward moving their ratings so that an increased number of ambiguous expressions become interpreted as happy rather than angry. Two open pilot studies suggested that IBT can lead to reduction in aggressive behavior[112] and irritability.[109] However, a double-blind randomized controlled trial of IBT vs a sham control condition in 44 children with DMDD failed to show effects on irritability or any other measures of clinical improvement.[113]

Clearly, more research is needed to investigate how well-validated child-directed interventions for irritability and aggression, such as CBT, can be adapted for technology-based delivery or enhanced by technologies such as virtual reality or computerized interpersonal bias training. Taken together, nascent studies of technology-based child-focused treatments for irritability and aggression suggest that technology can enhance engagement of youth in treatment, which could be particularly important for children with disruptive mood and behavior symptoms, as these may reduce motivation for treatment. There are also notable

limitations of telehealth, including lack of access to digital technology or private space to speak to a therapist from home. These challenges may disproportionately affect minority children, thus exacerbating disparities in access to services. Telehealth may also restrict perception of nonverbal context such as eye contact or tone of voice limiting the role of these communication signals in alliance formation and therapy process.[114]

Measurement-Based Care

MBC has gained increasing prominence as a method for improving patient outcomes in psychosocial interventions and may hold promise for enhancing the efficacy of treatments of childhood irritability and aggression by improving the focus on interventions on targeted symptoms. Defined as "the use of validated clinical measurement instruments to objectify the assessment, treatment and clinical outcomes … in patients with psychiatric disorders,"[115] MBC consists of 2 main components. The first component includes the continuous collection of data using validated measures. Measures used in MBC must have strong psychometric properties including good reliability and validity and sensitivity to change. The second component of MBC includes the use of collected data to inform treatment.[116] Specifically, clinical data collected at the outset of treatment can guide treatment selection, while data collected during treatment can serve to monitor treatment progress and inform flexible adaptations of treatment as needed.[117] For example, it is possible that children receiving treatment for disruptive behavior may present with elevated scores on both irritability and defiant behavior or with irritable mood but without defiance. This can inform selection of parent-focused vs child-focused interventions at the outset of treatment, and change in weekly symptom severity can inform treatment progress and whether additional treatment modalities need to be included. So far, MBC has been mostly studied in adult populations, with several reviews indicating positive impact on treatment outcomes.[118,119]

Regarding application of MBC within pediatric populations, several studies have evaluated the impact of MBC on overall mental health by using global measures of mental health symptoms to monitor treatment progress and outcomes. For example, in 2 randomized controlled studies of MBC in youth in community mental health clinics, the Symptoms and Functioning Severity Scale[120] a global measure of patient symptoms, was used to monitor and track clinical outcomes.[121,122] In both studies, MBC was associated with positive effects on youth symptoms. The use of MBC in children and adolescents has also been evaluated in the treatment of depression,[123,124] anxiety disorders,[125] and autism spectrum disorder.[126] Yet, to our knowledge, no studies have evaluated the use of MBC in the treatment of childhood irritability and aggression. Given the promise of MBC as well as the presence of well-validated measures for the assessment of irritability and aggression in youth, the use of MBC for the treatment of these problems warrants consideration. Measures that are likely to be useful in this capacity include the CBCL, the Disruptive Behavior Rating Scale (DBRS), the Home Situations Questionnaire (HSQ), the ARI, and the Modified Overt Aggression Scale (MOAS). Each of these measures is reviewed in detail here.

The CBCL[127] is one of the most widely used parent rating scales of child behavior. The CBCL includes age and gender norms and demonstrates excellent reliability and validity. The full CBCL includes 113 items that assess behavior and emotional functioning and comprises several syndrome scales. Each item is rated on a 3-point scale (0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true). The aggressive behavior scale, which consists of 18 items, assesses argumentativeness, excessive anger, and physical aggression. The aggressive behavior scale has a high internal consistency (0.92), which has been demonstrated in both referred and nonreferred children. As the CBCL is a norm-referenced assessment, a child's score on the aggressive behavior scale can be used to compare their level of aggressive behavior relative to peers of the same age and gender. Although historically most treatment studies have used a broad-band CBCL externalizing behavior scale, there is evidence that the CBCL aggressive behavior scale is sensitive to treatment change in children with disruptive behavior.[128,129]

The DBRS[71] is a parent-rated scale of irritability and oppositional behavior. The DBRS comprises 8 items that correspond to the *DSM* criteria for ODD, including "loses temper," "argues with adults," and "is angry or resentful." Items are rated on a 4-point scale (0 = never or rarely, 1 = sometimes, 2 = often, and 3 = very often). The internal consistency of the DBRS is high and ranges from 0.86 to 0.93, and total scores of 12 or higher are considered clinically significant.[130] The DBRS has been used as an outcome measure in studies of PMT and ACT in youth with disruptive behavior and Tourette's syndrome.[65,131]

The HSQ[71] is a parent-rated measure of child noncompliance. The HSQ includes 16 items, each of which corresponds to a different situation (eg, "at mealtimes," "at bedtime"). For each item/situation, parents indicate if their child demonstrates problems with compliance ("yes" or "no"). For items that are answered "yes," parents rate the severity of the noncompliance on a 9-point scale (1 = mild and 9 = severe). The HSQ yields 2 separate scores, the total number of problem situations and the mean severity score

(sum of severity scores across the total number of items). The HSQ has been used as an outcome measure and has demonstrated sensitivity to change in evaluations of PMT for irritability in children with autism.[132,133]

The ARI[99] is rating scale of irritability that can be completed by the parent (parent-report) or the child (self-report). The ARI includes 7 items, with the first 6 items assessing symptoms of irritability (eg, "easily annoyed by others," "get angry frequently") and the last item assessing impairment caused by irritability. Items are rated on a 3-point scale (0 = not true, 1 = somewhat true, and 2 = certainly true). Scores on the first 6 items are used to calculate the total irritability score, and total scores of 3 or higher are considered clinically significant. Internal consistency on the ARI is high, with a range of 0.88 to 0.92 for parent-report and 0.79 to 0.90 for self-report.[99,134] Although a relatively new measure, the ARI has demonstrated sensitivity to change in the treatment of pediatric irritability.[98]

The MOAS[135,136] is a clinician-rated measure of aggressive behavior that is conducted via interview with the parent. The MOAS includes 16 items that assess the frequency and severity of aggressive behavior across 4 categories: verbal aggression, aggression against objects, self-directed aggression, and aggression against others. Items are rated on a 4-point scale assessing the frequency of behavior in the past week (1 = none, 2 = 1 or 2 times, 3 = 3 or 4 times, 4 = 5 or more times). Each item is then given a weighted score corresponding to the harmfulness of the behavior. The MOAS has good reliability, with an internal consistency of 0.78 and an interrater reliability of 0.87.[64] The MOAS has been used as an outcome measure and has demonstrated sensitivity to change in several clinical studies for children with irritability and aggressive behavior.[137,138]

Another method for the MBC assessment of irritability and aggression includes the use of parent-nominated target problems (PTP).[139] In contrast to parent- or clinician-rated scales, which require respondents to assign ratings to a preset list of behaviors, PTP ratings require parents to identify the most concerning behaviors (ie, target problems) for their child. Parents identify target problems during a conversation with a clinician, who then obtains information about the problems and assigns ratings to each behavior. The use of PTP ratings has been evaluated in 2 clinical trials targeting the reduction of disruptive behavior in children with Tourette's syndrome.[139] In the first trial, families of children 6 to 11 years of age were randomly assigned to receive PMT or treatment as usual. In the second trial, adolescents were randomly assigned to receive CBT or treatment as usual. In both trials, parents met with a clinician at the pretreatment assessment to nominate target problems. Parents nominated 2 target problems, following which the clinician created a narrative that described the problems and their frequency, intensity, duration, and impact on the family. Following treatment, parents met with the clinician again to review the current status of the target problems, and an updated narrative was created. Change in status of target behaviors from pre- to post-treatment was coded by 5 independent raters using a 7-point scale that paralleled the Clinical Global Impressions improvement scale (1 = very much improved to 7 = very much worse). Results from both trials demonstrated strong psychometric properties for the PTP ratings, including excellent interrater reliability and good convergent validity with the DBRS. PTP ratings were also sensitive to change and showed treatment effects comparable to those of the DBRS. Further, PTP ratings predicted global symptom improvement above and beyond that predicted by the DBRS, suggesting that the PTP ratings capture uniquely important information about improvement in symptoms following treatment for disruptive behavior. Combining the use of well-validated rating scales and PTP ratings may provide an important way to monitor and assess treatment progress and outcomes in the context of MBC for irritability and aggression in youth.

DISCUSSION

Irritability and aggressive behavior are among the most common reasons that children and adolescents are referred for mental health care services. Several parent- and child-focused psychosocial treatments for these problems exist, some with decades of research support and some more recent. PMT is an intervention with extensive support that is based on social learning principles and aims to alter parenting practices that reinforce and maintain disruptive behaviors including aggression and temper outbursts. CBT is another well-established treatment for children with anger and aggression. Technology-based interventions for the treatment of childhood aggression, such as online programs of PMT and the use of telehealth delivery, also show positive treatment effects and provide an important platform for increasing accessibility to services. Lastly, MBC, while still a new area in child mental health care, may provide a promising avenue for a more targeted treatment of childhood irritability and aggression.

The reviewed evidence in support of these interventions should be considered in light of evolving understanding of the constructs of irritability and aggression in the context of disruptive mood and behavior disorders. Most treatment studies have enrolled children based on overlapping but different inclusion criteria for the presence and severity of disruptive behavior, conduct problems, antisocial behavior, or externalizing disorders and have used broad outcome measures of these symptoms, such as

the CBCL externalizing problems scale[127] or Eyberg Child Behavior Inventory.[140] This makes it difficult to estimate the effects of treatments such as PMT and CBT, which have been tested in hundreds of studies over the past 40 years, on narrowly defined symptom clusters of aggression and irritability. To address this limitation of the extant research, we highlighted studies that used outcome measures that map on the current (as of November 2023) conceptualization of childhood aggression and irritability. Additionally, we provided a detailed review of recent studies that specifically included subjects with severe mood dysregulation and irritability with emerging evidence that a combination of PMT and CBT and adaptations of DBT for children are likely to be useful.

Another important consideration in treatment studies of aggression and irritability is the age of study participants. The majority of studies of behavioral parenting training have been conducted in young children and school-age children with a notable exception of Barkley's PMT[141] approach, which was tested in 2 randomized trials in adolescents 12 to 17 years of age with ADHD complicated by behavioral problems.[142] The general principles of PMT are likely to be highly relevant for older adolescents seeking treatment for maladaptive aggression, but need to be applied with careful consideration of key features of this developmental period, such as the increasing need for respect and autonomy.[143] There is also evidence that child-focused interventions such as CBT are more effective in adolescents than in young children.[144] Treatments for serious forms of conduct problems and delinquency in older adolescents have been tested mostly in juvenile justice involved populations, and well-established programs include multisystemic therapy and functional family therapy.[145,146]

Regarding the format of treatment delivery, it should be noted that most studies of PMT and CBT have been conducted in group format. While group administration may be more practical in school and hospital settings and allow for peer-to-peer discussions and role-plays, there are also limitations to how group therapy studies can inform real-world clinical settings where psychosocial interventions are most likely to be conducted in the format of individual child psychotherapy with or without the parent. To this end, well-designed and adequately powered clinical trials of individually administered psychosocial interventions for aggression and irritability are sorely missing. Evidence from meta-analyses suggests that for children with clinically significant levels of behavioral problems, combined parenting and child interventions were more effective when administered individually than in group-based formats.[147]

Regarding diagnostic status and comorbid conditions, several studies demonstrated effectiveness of psychosocial intervention on reduction of irritability in children with ADHD as a primary diagnosis,[148] and a considerable body of research has been conducted on parenting interventions for irritability in autism spectrum disorder.[132,133,149–151] There is also evidence that PMT and CBT can reduce irritability and anger outbursts in children and adolescents with Tourette's syndrome [65,131] and in children with obsessive-compulsive disorder.[152] However, despite high levels of comorbidity associated with disruptive behavior and mood disorders, surprisingly little is known about potential mediating effects of co-occurring disorders on the outcomes of psychosocial interventions for aggression and irritability. Two notable exceptions include findings from meta-analytic reviews of no significant moderating effects of ADHD diagnosis[153] or the presence of callous-unemotional traits on the outcomes of parenting interventions.[25] There is also surprisingly little research on exposure to adversity and traumatic events as possible mediators of response to treatment for aggressive behavior and irritability. Yet, there is considerable research on conduct problems and emotion dysregulation in children exposed to early adversity or traumatic events[154,155] as well as studies of the effects of traumatic experiences on social information processing[156,157] and irritability.[158] Given this research base, a meta-analytic review investigating potential moderating effects of exposure to adversity and traumatic events on the outcomes of psychosocial interventions for aggression and irritability would be helpful.

The limitations of the extant evidence base can be addressed in well-powered randomized controlled trials with outcome measures that reflect current conceptualizations of maladaptive aggression and irritability, include adolescents, and examine the role of co-occurring psychopathology in treatment response. Future research should also continue to focus on how new advances in technology can be applied to the treatment of these problems. Further, more work is needed to better understand whether and how certain treatments work best for children with certain patterns or profiles of irritability and aggressive behavior.

CRediT authorship contribution statement

Carla Kalvin: Writing – original draft, Conceptualization. **Julia Zhong:** Writing – review & editing. **Megan Rutten:** Writing – review & editing. **Karim Ibrahim:** Writing – review & editing, Conceptualization. **Denis G. Sukhodolsky:** Writing – review & editing, Resources, Funding acquisition, Conceptualization.

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