

# Systematic Review: A Reevaluation and Update of the Integrative (Trajectory) Model of Pediatric Medical Traumatic Stress

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## Abstract

**Objective** The objective of this systematic review is to reevaluate and update the Integrative Model of Pediatric Medical Traumatic Stress (PMTS; Kazak et al., 2006), which provides a conceptual framework for traumatic stress responses across pediatric illnesses and injuries.

**Methods** Using established systematic review guidelines, we searched PsycINFO, Cumulative Index to Nursing and Allied Health Literature, and PubMed (producing 216 PMTS papers published since 2005), extracted findings for review, and organized and interpreted findings within the Integrative Model framework. **Results** Recent PMTS research has included additional pediatric populations, used advanced longitudinal modeling techniques, clarified relations between parent and child PMTS, and considered effects of PMTS on health outcomes. Results support and extend the model's five assumptions, and suggest a sixth assumption related to health outcomes and PMTS. **Conclusions** Based on new evidence, the renamed Integrative *Trajectory* Model includes phases corresponding with medical events, adds family-centered trajectories, reaffirms a competency-based framework, and suggests updated assessment and intervention implications.

**Key words:** families; illness; injury; medical traumatic stress; pediatric; traumatic stress.

Pediatric illnesses and injuries affect many children, adolescents, and families and often involve potentially traumatic experiences. The [National Child Traumatic Stress Network \(2003\)](#) defined pediatric medical traumatic stress (PMTS) as “a set of psychological and physiological responses of children and their families to pain, injury, serious illness, medical procedures, and invasive or frightening treatment experiences.” These reactions often include (but are not limited to) posttraumatic stress symptoms (PTSS), including reexperiencing, avoidance of reminders of the trauma, and hyperarousal. While evidence regarding psychological reactions to pediatric medical experiences has

often been published in separate literatures for specific illness or injury types, the Integrative Model of Pediatric Medical Traumatic Stress (Integrative Model; Kazak et al., 2006) provides a conceptual framework for understanding the psychological reactions of children and families across many different types of pediatric injury and illness.

The Integrative Model describes child and family adjustment across three consecutive phases. Phase I: Peritrauma, includes the initial Potentially Traumatic Event (PTE) and surrounding events, such as those related to an accident scene, transport to the hospital, invasive medical procedures, or communication of the

diagnosis of a life threatening injury or illness. Phase II: Early, Ongoing, and Evolving Responses, includes active medical treatment and related demands. Phase III: Longer-term PMTS, refers to the time past the end of active medical treatment, highlighting the potential for traumatic responses to continue for months or years. The Integrative Model includes goals for intervention at each phase: changing the subjective experience of the PTE in Phase I, preventing PTSS in Phase II, and reducing PTSS in Phase III.

The model rests on five assumptions. The first is that *there are commonalities (common dimensions) across illnesses and injuries related to PTEs*. PMTS is a common reaction after potentially traumatic medical events across multiple pediatric conditions; however, variability is found in prevalence rates across conditions. This suggests that there are commonalities across illnesses and injuries, but also variation on common dimensions that are risk or protective factors for PMTS. These common dimensions may relate to the characteristics of the medical events, such as the nature of its onset, the intensity and duration of treatment, and the threat of reoccurrence or long-term complications and subjective perceptions about the events. Second, *there is a range of normative reactions to a medical PTE*. When children, parents, and families experience a PTE, a period of distress and adjustment is expected and typical. There is variation in these reactions, and they are not necessarily indicative of a mental health diagnosis or considered pathological. Third, *patients and families have a range of preexisting psychological functioning that influences risk for PMTS*. The majority of families and children who enter the health care system are competent and functioning adaptively in daily life before the onset of pediatric illness or injury; however, a significant subset are not and they are at risk for ongoing difficulties and escalation in symptoms. Fourth, *a developmental lens on medical trauma is essential*. Children and adolescents interpret and understand illness and injury differently across time, and their developmental stage informs appropriate assessment and intervention practices and level of involvement of parents. Fifth, *a social ecological or contextual approach is optimal for intervention*. Children who enter the health care system live in complex environments defined by multiple systems, including family, school, and broader community systems that provide the context in which they respond to PTEs.

## Aims of the Review

Since the Integrative Model was published, nearly one decade ago, research in this field has grown significantly. There have been multiple systematic literature reviews and meta-analyses focused on PTSS across pediatric illness and injury groups (Kahana, Feeny, Youngstrom, & Drotar, 2006), risk factors for PTSS

following pediatric injury (Brosbe, Hoefling, & Faust, 2011; Cox, Kenardy, & Hendrikz, 2008), posttraumatic stress disorder (PTSD) in parents of children with chronic illnesses (Cabizuca, Marques-Portella, Mendlowicz, Coutinho, & Figueira, 2009), and PTSD as a framework for understanding distress related to pediatric cancer (Bruce, 2006). Nonsystematic literature reviews of PTSS in response to pediatric burns (Bakker, Van der Heijden, Von Son, & Van Loey, 2013), critical care units (Davydow, Richardson, Zatzick, & Katon, 2010), unintentional injury (Gold, Kant, & Hyeon Kim, 2008), and hematopoietic stem cell transplantation (Packman, Weber, Wallace, & Burgesscu, 2010) have also been conducted, as well as a review of the psychobiology of PTSD in pediatric injury (Langeland & Olff, 2008). Some systematic reviews are peripherally related, examining general psychological functioning of children who are critically ill and the impact of childhood illness on the family (including PTSS; Rennick & Rashotte, 2009). The goals of the present systematic review extend beyond previous reviews to provide a reevaluation and update to the Integrative Model. Specific aims are to: (a) reevaluate the model's assumptions in light of accruing evidence, (b) summarize research on assessment and intervention practices for PMTS, and (c) update the model congruent with new evidence.

## Methods

### Data Sources and Study Selection

A literature search of peer-reviewed papers published in English between January 1, 2005 and December 31, 2014 was conducted using PsycINFO, Cumulative Index to Nursing and Allied Health Literature, and PubMed. Search terms were "pediatric illness" or "pediatric injury" or "pediatric procedure" AND "traumatic stress" or "posttraumatic stress disorder" or "acute stress disorder" (ASD). Papers were included if they reported data on children with illness or injury or their parents. References in extracted articles were reviewed to identify additional papers. Articles that cited the Integrative Model (Kazak et al., 2006) were also considered. Studies were excluded if they were cited in the original article (Kazak et al., 2006), involved adult injury or illness samples, focused on physical instead of psychological trauma, concerned nonmedical child trauma, or did not mention traumatic stress, ASD, or PTSD in the abstract. This methodology was based on recommendations for systematic reviews in pediatric psychology (Palermo, 2013).

### Review Process

The computerized literature searches and review of reference sections identified 600 articles (with duplicates removed). Two authors (J.C., J.P.) independently

used inclusion and exclusion criteria to identify eligible articles. There was 98% agreement on the selected articles and diverging views were discussed until agreement. A total of 216 papers met inclusion criteria. A reference list of these papers is available in the [Supplementary Tables](#). Papers included systematic reviews ( $n = 9$ ), nonsystematic reviews ( $n = 22$ ), meta-analyses ( $n = 3$ ), and empirical studies ( $n = 182$ ), of which 13 were randomized controlled trials (RCTs). Few empirical studies included qualitative methods ( $n = 4$ ). Although systematic reviews often only include individual empirical studies, the aim of the current review is to update a broad conceptual framework for PMTS so all available information (e.g., reviews, meta-analyses) was considered.

### Data Extraction

Two authors (J.C., J.P.) independently extracted data from eligible studies, including the year of publication, type of article (e.g., meta-analysis, single research study), study population (i.e., pediatric illness/injury group), study focus as it related to the Integrative Model (e.g., assumptions of the model), and rates of PMTS (if applicable). For eligible empirical papers, the authors also extracted data regarding methods (e.g., longitudinal) and study participant information. Each author checked the data extraction conducted by the other.

### Evaluation of Study Quality and Potential Bias

The extracted data were used to evaluate the quality of individual studies and summarize the overall strength of the literature. Specifically, sample size, use of established measurements, multimodal/multi-informant assessments, chart review methodologies, retrospective recall, and prospective approach were considered when evaluating the rigor of studies included in this review. Appropriateness of methods (e.g., research design, instruments used, statistical approach) for the research question was also considered.

## Results

### Reevaluation of the Underlying Assumptions of the Model

*Assumption 1: There are Commonalities (Common Dimensions) Across Illnesses and Injuries Related to PTEs.* Recent studies confirm that PMTS is evident across various illness and injury groups and that risk/protective factors for PMTS are similar across a wide array of pediatric populations. Nuanced differences in prevalence of PMTS have been documented, and these differences may reflect variation across medical events on common dimensions related to PTEs (e.g.,

medically related factors, subjective interpretations), thus supporting the first assumption of the Integrative Model.

The Integrative Model was conceptualized using evidence from multiple pediatric populations, including acute or life-threatening conditions (i.e., cancer, transplant and cardiac surgeries, intensive care), chronic illness (i.e., new onset type 1 diabetes), and injury (e.g., motor vehicle accidents, burns; [Kazak et al., 2006](#)). Although pediatric cancer (45 articles since 2005) and injury (107 articles since 2005) continue to dominate the literature, the evidence base is expanding. Specific types of pediatric injury have garnered recent research attention, including articles related to burns ( $n = 21$ ), motor vehicle accidents ( $n = 19$ ), and traumatic brain injury ( $n = 5$ ). In the areas of premature infants ( $n = 4$ ), diabetes ( $n = 5$ ), cardiology ( $n = 9$ ), and intensive care ( $n = 21$ ), research on PMTS continues to grow since 2005. One to two articles evaluated PMTS in each of the following groups since publication of the Integrative Model: animal-related injury, asthma, spina bifida, sickle cell disease (SCD), meningococcal disease, human immunodeficiency virus (HIV), and general congenital disease. Taken together, there is growing evidence that PMTS is present across pediatric illnesses and injuries.

Overall, rates of PMTS in children, adolescents, and parents are roughly 30% when including subclinical PTSS, and there is a decline in symptoms over time. Estimates of PMTS prevalence within illness or injury groups range significantly, likely owing to differences in assessment strategy (e.g., interview vs. self-report checklist), potential bias of parent reports (e.g., conflating parent and child symptoms), timing of assessment relative to the PTE, and criteria considered (e.g., PTSD, ASD, subclinical symptoms). Pediatric injury and cancer offer the largest number of estimates of prevalence of PMTS. Child PMTS rates range from 22 to 42% in the first month after pediatric injury, 1 to 38% two to nine months postinjury, and from 10 to 19% ten months or more postinjury. Parent PMTS related to pediatric injury appears to decline significantly over time, from 10 to 22% in the first month, 5 to 11% roughly six months postinjury and 0 to 18% ten months or more postinjury. In the cancer literature, parental PMTS estimates decline initially but then appear to remain stable across the first year postdiagnosis. Within the first month, 40–83% of parents exhibit PMTS, whereas at 6 months and >10 months postdiagnosis, PMTS rates range from 18 to 33% and 7 to 27%, respectively. While there is great variability within condition, rates of PMTS appear to be higher among parents of children with cancer compared with those experiencing injury. Studies examining youth PMTS in cancer focus nearly exclusively on survivors of cancer rather than those

newly diagnosed. Among survivors of childhood cancer, child PMTS rates range from 8 to 75% and parent PMTS ranges from 20 to 22%.

Although fewer studies consider PMTS in other pediatric populations, prevalence estimates suggest some similarities in longitudinal patterns compared with injury and cancer. For example, in the diabetes literature, estimates of parental PMTS over the first 6 weeks (5–24%) to 6 months (10–42%) appear similar to those in parents of children with injury. However, similar to parents of children with cancer, rates of PMTS stabilize at  $\geq 10$  months following diabetes diagnosis (7–20%). Among parents of youth admitted to intensive care, 12–84% endorse some PMTS within the first 6 weeks of admission and 13–30% continue to experience PMTS roughly 6 months postdischarge. In a sample of 104 adolescents with liver, heart, or kidney transplant at least 1 year prior, 16% of youth met diagnostic criteria for PTSD and an additional 14% met criteria in two of the three symptom clusters (Mintzer et al., 2005), a more persistent pattern of PMTS similar to parents of children with cancer. Although the preliminary nature of these data preclude definitive conclusions, differences in PMTS prevalence among pediatric conditions across time may be related to variability in medically related factors, including chronic compared with acute course or treatment of the condition and risk of complication or reoccurrence.

Only two studies have directly compared PTSD rates across pediatric conditions. For children, no significant differences were observed in PTSD rates in one study comparing those with HIV (8%), SCD (7%), or transplant (15%; Ingerski, Shaw, Gray, & Janicke, 2010), but in a second study, PTSD rates were higher in those with a new cancer diagnosis (7%) or an unintentional injury (16%) compared with children newly diagnosed with diabetes (4%; Landolt, Ystrom, Sennhauser, Gnehm, & Vollrath, 2012). For parents, more PTSD symptoms were reported in families facing transplant compared with HIV or SCD in the first study (Ingerski et al., 2010). In the second study, PTSD was more prevalent for parents of children newly diagnosed with cancer (40–50%) compared with those whose children were injured (11–19%) or had a new diabetes diagnosis (12–24%; Landolt et al., 2012). These novel studies offer preliminary evidence of potentially important differences in PMTS rates across pediatric populations that may be linked to differences in these conditions across common dimensions. Although children with cancer, injury, and diabetes often experience similar medical events, including hospitalizations and invasive or painful procedures, these medical experiences may be more frequent and intense or more severely distressing for children with cancer or injury than for children with diabetes. Parents of children undergoing

transplant surgery or newly diagnosed with cancer may perceive a greater threat to the lives of their children and perceive their treatment to be more invasive and complex than parents of children with HIV, SCD, diabetes, or an unintentional injury.

Since 2005, 2 systematic reviews, 1 meta-analysis, 1 narrative review, and 21 empirical studies identified medically related factors that predict PMTS for illness and injury groups. For example, in pediatric cancer, diabetes, or injury, length of hospital stay and poor outcome predicted parent and child PTSS (Brosbe et al., 2011; Gerhardt et al., 2007; Jurbergs et al., 2009; Landolt et al., 2012; Landolt, Vollrath, Laimbacher, Gnehm, & Sennhauser, 2005; Ozono et al., 2007). An additional 11 empirical articles examined but found no significant associations between medically related factors and PTSS (e.g., Board & Dai, 2011; Stoppelbein, Greening, & Wells, 2013). One meta-analysis concluded that the strength of medically related factors as predictors of PTSS may vary across samples (Kahana et al., 2006).

Across injury and illness, child and parent subjective interpretation of medical events, such as perception of life threat, continues to be one of the most powerful predictors of PMTS. A recent meta-analysis of pediatric injury suggested a moderate effect size ( $r = .38$ ) for subjective life threat (Cox et al., 2008). Subjective appraisals of trauma severity and life threat produced a medium to large effect size in another meta-analysis examining predictors of PTSS in pediatric injury and illness samples (Cohen's  $d = 0.39$ – $0.82$ ; Kahana et al., 2006), providing further support for this common dimension across pediatric conditions. History of psychological problems is another PMTS risk factor common to children and parents who experience pediatric illness and injury and is discussed further in Assumption 3. Recent studies identify a range of other risk factors for pediatric illness- or injury-related PTSS, such as genetic factors (Amstadter et al., 2011) and cortisol levels (Stoppelbein, Greening, & Fite, 2010). The recent literature continues to support commonalities in risk factors for PMTS across pediatric conditions.

*Assumption 2: There is a Range of Normative Reactions to a Medical PTE.* Children and families respond to pediatric illness and injury with varying levels of distress, with most being able to cope effectively and access needed supports. A smaller portion of youth and parents demonstrate high levels of lasting distress that interfere with meeting family, work, or medical care demands. Children and parents may also experience positive changes in their world view, interpersonal relationships, and self-concept, or posttraumatic growth (PTG). Since the Integrative Model was first proposed, 88 cross-sectional and 68 longitudinal studies of PTSS have been published. This recent research supports the second assumption of the



Integrative Model and extends our understanding of the range of normative reactions from a broad, static perspective to one that elucidates reactions across time following pediatric injury and illness.

Recent studies continue to support the competency of families, as well as the need for psychosocial intervention among a subset. Consistent across pediatric illnesses and injuries is evidence of a small portion of children and parents demonstrating clinically significant PTSD, an additional subset exhibiting elevated PTSS, and the largest group reporting no or minimal PTSS (Ingerski et al., 2010; Landolt et al., 2012). Two independent studies modeled trajectories of PTSS/PTSD following pediatric injury, one concerning preschool children with minor unintentional burn injuries ( $N=130$ ) and the second regarding 6 to 16-year-olds postinjury ( $N=190$ ) and their parents ( $N=189$ ; DeYoung, Kenardy, Cobham, & Kimble, 2012; Le Brocque, Henrikz, & Kenardy, 2010a, 2010b). Together, these studies suggest four distinct trajectories: resilient (minimal PTSS following injury), recovery (initial PTSD or elevated PTSS that remits within 1–3 months), chronic (consistently elevated PTSS or PTSD for 6–24 months postinjury), and delayed onset (new onset PTSD diagnosis 6 months postinjury). The majority of children follow a resilient (57–72%) pathway following postinjury, fewer children follow the recovery (18–33%) trajectory, and the smallest proportion of children follow the chronic (8–10%) and delayed-onset (2%) longitudinal patterns. The proportion of parents following each trajectory varied somewhat from children, with 78, 8, and 14% following resilient, recovery, and chronic pathways. These findings are similar to those regarding trajectories of psychosocial functioning in adults responding to other types of trauma (Bonanno & Diminch, 2013). This preliminary evidence of trajectories of PMTS is consistent with the Integrative Model, illustrating the range of psychological response to pediatric medical experiences and suggesting an update of the model to reflect longitudinal patterns of reactions.

There is a dearth of research examining PTG after pediatric medical events, with only four studies identified since 2005. Most of these ( $n=3$ ) examined PTG in cancer; one considered PTG among children undergoing corrective surgery for congenital disease and none evaluated PTG in the context of pediatric injury. Key findings are that children and parents report positive changes following a cancer diagnosis (Barakat, Alderfer, & Kazak, 2006) and that conflicting evidence regarding the relation between PMTS and PTG exists (Barakat et al., 2006; Klosky et al., 2014). Additional prospective evaluation of PTG is needed to assess whether this reaction is common to pediatric illness and injury. Changes to the Integrative Model are not yet supported.

*Assumption 3: Patients and Families Have a Range of Preexisting Psychological Functioning That Influences Risk for PMTS.* The majority of families and children who enter the health care system are competent and functioning adaptively in daily life before the onset of pediatric illness or injury. For children and families with preexisting psychosocial difficulties, such as prior emotional or behavioral problems and previous exposure to a PTE, risk of PTSS and PTSD is higher. Twenty-one articles, including 2 meta-analyses, 3 systematic and 3 narrative reviews, and 13 empirical papers, examined this assumption. A meta-analysis evaluating risk factors for PTSS found that preinjury psychopathology was one of the strongest predictors of PTSS among youth ( $r=.22$ ; Cox et al., 2008). Results from a systematic review of the pediatric accidental injury literature support this association (Brosbe et al., 2011), as do studies of PTSS trajectories after injury (Le Brocque et al., 2010a). Similarly, among survivors of childhood cancer and their parents, as well as other critical illness populations, preexisting mental health issues (e.g., history of mental disorder, psychopathology, dispositional anxiety) increases risk for PTSS and acute stress (Davydow et al., 2010; Patino-Fernandez et al., 2008; Schrag, McKeown, Jackson, Cuffe, & Neuberg, 2008). In sum, recent findings are consistent with the Integrative Model; preexisting psychological functioning of children and parents remains variable across injury and illness, with prior externalizing and internalizing difficulties conferring risk for PMTS.

*Assumption 4: A Developmental Lens on Medical Trauma is Essential.* The Integrative Model assumes that developmental level is central to understanding PTSS related to pediatric injury and illness, particularly as it informs intervention. Since 2005, empirical ( $n=22$ ), systematic ( $n=3$ ) and nonsystematic ( $n=1$ ) reviews, and meta-analytic ( $n=3$ ) articles have considered age as a risk factor for PTSS related to pediatric injury and illness. Although recent findings are mixed, developmental period remains an important consideration for assessment and intervention for PMTS. The fourth assumption of the Integrative Model is largely supported, although limitations in the methodology (e.g., use of age as a proxy for developmental level) indicate a need for more rigorous research in this area.

The recent literature highlights differences in risk for PMTS across developmental periods and extends previous literature in considering prospective risk for PTSS by age at diagnosis. Results from meta-analyses provide mixed support for younger age as a risk factor for PTSS (Cabizuca et al., 2009; Cox et al., 2008; Kahana et al., 2006). Among injured children, a systematic review and one study found some evidence for younger school-aged youth to be at greater risk for

PTSS immediately postinjury but not for persistent PTSS (Brosbe et al., 2011; Le Brocque et al., 2010a). Developmental period appears to influence both concurrent and longitudinal risk for PTSS. For example, adolescents who were diagnosed with cancer after age 5 years had higher rates of persistent PTSS compared with those diagnosed at a younger age (Barakat et al., 2006). Developmental factors such as increasing ability to understand and recall the diagnosis and treatment of cancer may account for these developmental differences (Barakat et al., 2006) and for differences in PMTS across children and parents, although empirical investigations of this hypothesis are lacking in the current literature.

Since 2005, 13 RCTs (11 within the injury literature) provide data regarding the efficacy of preventive interventions within varying age-groups but findings are mixed. Two RCTs out of the University Children's Hospital Zurich provide examples of how developmental stage may affect response to intervention, with both demonstrating greater efficacy among school-aged children compared with preschool or adolescent children (Kramer & Landolt, 2014; Zehnder, Meuli, & Landolt, 2010). Some studies have examined age as a predictor or moderator of intervention outcome, with no evidence of a significant relationship between age and outcome for psychological or pharmacological prevention (Kassam-Adams, Garcia-Espana, Marsac, & Kohser, 2011; Nugent et al., 2010).

Recent changes in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association, 2013) include some recognition of developmental differences with the addition of the preschool subtype of PTSD. Some pediatric illnesses (e.g., cancer) and injuries (e.g., burns) are more common among infants, toddlers, and preschool-aged children so these changes to PTSD in the DSM-5 are highly applicable to PMTS.

*Assumption 5: A Social Ecological or Contextual Approach is Optimal for Intervention.* As described in the Integrative Model, considering the child within the context of multiple interacting systems is essential to effective interventions for PMTS. Children who enter the health care system live within a complex environment defined by multiple systems, from family to medical providers and even broader systems, such as school and community supports (e.g., clergy). Much of the PMTS research in the past decade that examined systems beyond the individual child has focused on prevalence of PTSS among parents (99 articles), the association between parent and child PTSS (16 articles), and PTSS in siblings (6 articles). Few studies have considered effects of parent PTSS on parenting (1 article) or the role of poor family functioning (3 articles). No studies identified for the current review evaluated the role of more distal systems

in PMTS (e.g., school, community). Overall, recent findings support the fifth assumption of the Integrative Model, particularly the role of the proximal environmental factors in PMTS, and suggest that the role of parents should be more explicitly integrated into the model of PMTS.

Research over the past decade provides further evidence of PTSS in parents of children with chronic or acute illnesses or injury, and extends understanding of how parent and child PTSS are related. A meta-analysis examining the prevalence of PTSD in parents of youth with chronic illness found a PTSD prevalence rate of roughly 20% (Cabizuca et al., 2009), with assessments ranging from 5 weeks to nearly 7 years postdiagnosis. Other recent empirical studies suggest that parents, and mothers specifically, may be at greater risk for PTSS compared with youth and fathers, respectively (Cabuzica et al., 2009; Franich-Ray et al., 2013; Landolt et al., 2012). Although there is some evidence that child-specific factors (but not child PTSS) may influence parental PTSS (Bakker, Van Loey, Van der Heijden, & Van Son, 2012), a larger evidence base suggests that parental PTSS increases risk for, and maintenance of, child PTSS (Brosbe et al., 2011; DeYoung, Hendrikz, Kenardy, Cobham, & Kimble, 2014; Landolt et al., 2012; Nugent, Ostrowski, Christopher, & Delahanty, 2007). In sum, parent and child PTSS patterns are related (Le Brocque et al., 2010b; Ostrowski, Christopher, van Dulmen, & Delahanty, 2007) and a family-centered approach to assessment and treatment of PMTS is essential.

Other contextual factors, such as sibling and overall family functioning, influence family psychological reactions to pediatric injury and illness, but there is limited research in this area. There is a small literature documenting PTSS among siblings of children with cancer, with only four articles published since 2005. Results from a systematic review of the adjustment of siblings of children with cancer indicated that although siblings typically do not exhibit psychiatric disorder, PTSS and poorer quality of life occur in a subset of siblings (Alderfer et al., 2010). A similarly small literature suggests poor family functioning is related to PTSS among those who experience pediatric injury and cancer.

Parent PTSS not only affects the daily functioning of the caregivers, but may also impact parenting practices and readiness to meet the demands of medical care for children. However, only one qualitative study evaluated this possibility. The study regarding parenting following pediatric injury suggests that responsive parenting styles support child recovery (e.g., being aware of and responding to child's needs), although parents report that their own distress interferes with use of this parenting style (Alisic, Boeije, Jongmans, & Kleber, 2012). Avoidance symptoms

may be particularly detrimental to family functioning and health outcomes, given the need for follow-up medical care common to a range of pediatric illnesses and injury. However, there is some evidence that greater parental acute stress symptoms and greater parental perception of child acute stress symptoms are associated with greater utilization of medical services following pediatric injury (Marsac, Cirilli, Kassam-Adams, & Winston, 2011).

*New Assumption: PMTS Affects Health Outcomes.* Although the Integrative Model did not explicitly articulate relations between PMTS and health outcomes, recent research provides evidence of this link. Since 2005, 18 studies have evaluated the effect of PMTS on physical health outcomes and health-related quality of life (HRQOL). Symptoms of PTSS have been associated with increased risk of reinjury (Johnston & Martin-Herz, 2010), deficits in HRQOL (Colville & Pierce, 2013; Holbrook et al., 2005; Landolt, Vollrath, Gnehm, & Sennhauser, 2009; Martin-Herz, Zatzick, & McMahon, 2012; Zatzick et al., 2008), and poorer school and physical functioning (O'Connor et al., 2012). These findings indicate that subclinical and clinical levels of PTSS have important implications for physical health outcomes among families experiencing pediatric injury and illness. Given this new evidence, a sixth assumption is indicated.

### Assessment and Intervention for PMTS: Summary of Recent Research

Research on assessment and interventions for PMTS has increased over the past decade, particularly regarding screening (10 articles), early and brief preventive interventions (14 articles), web-based intervention (4 articles), and preventive psychiatric medication (3 articles).

Pediatric injury research (10 studies since 2005) provides much of the evidence for early screening (i.e., hours or days postinjury) predicting later PTSS and PTSD. Most screens for PTSS risk have focused on school-age children and adolescents with unintentional injury, although some recent studies have evaluated preschool-aged children (Kramer, Hertli, & Landolt, 2013) and those with burn injuries specifically (Pelley et al., 2013). The Child Trauma Screening Questionnaire, a brief child self-report questionnaire, has been found to outperform other screening measures in identifying children who will have PTSS 6 months postdischarge, particularly when combined with heart rate immediately following injury (Kenardy, Spence, & Macleod, 2006; Olsson, Kenardy, DeYoung, & Spence, 2008). One study examined feasibility of nurse-administered screening for risk of PTSD in an emergency department, with some support for feasibility and acceptability from nursing staff (Ward-Begnoche et al., 2006).

In the past decade, there have been 11 RCTs and 3 nonrandomized trials evaluating preventive and indicated interventions for PMTS. Many PMTS interventions use a family-centered approach and involve parents and children. RCTs have provided mixed evidence for early intervention following pediatric injury (Kassam-Adams et al., 2011; Kramer & Landolt, 2014), and some preliminary support for early interventions for mothers of preterm infants (Shaw et al., 2013, 2014). To the best of the authors' knowledge, no RCTs in the treatment of PMTS among pediatric illness have been published since 2005; however, two nonrandomized trials, one of cognitive-behavioral intervention for long-term survivors of childhood cancer and one of acceptance and commitment therapy for parents of children with life-threatening illness, have contributed to this literature (Burke et al., 2014; Seitz et al., 2014). Although little data are available regarding intervention acceptability, one mixed-methods analysis for families with pediatric cancer suggests a preference for parent-only intervention within 2–6 months of diagnosis, matched to the parents' trajectory of adjustment following diagnosis (Hocking et al., 2014).

Internet-based interventions have gained research attention in both the pediatric injury and cancer fields, with two RCTs and two nonrandomized intervention studies since 2005. Two RCTs of psychoeducation-focused Internet interventions yielded mixed evidence of efficacy (Marsac et al., 2013), with some preliminary evidence of decreased anxiety among intervention compared with controls (Cox, Kenardy, & Hendrikz, 2010). A pilot study yielded some evidence that an internet-based cognitive-behavioral intervention for long-term survivors of pediatric cancer may lead to decreases in PTSS among other emotional difficulties (Seitz et al., 2014). Research in psychopharmacological interventions, such as use of propranolol or sertraline, for PMTS has produced mixed findings, with some evidence that early treatment may have beneficial, detrimental, or no effect (Nugent et al., 2007; Stoddard et al., 2011).

### Discussion

This systematic review of recent research on PMTS reveals findings that are highly consistent with the Integrative Model and indicates important updates to the model. There has been a significant growth in research on PMTS over the past decade including numerous prospective investigations across many pediatric populations. Limitations in this growing literature point to areas that should be addressed in future research.

### Integrative Trajectory Model of PMTS

A large body of recent literature informs an update and expansion of the model, now called the

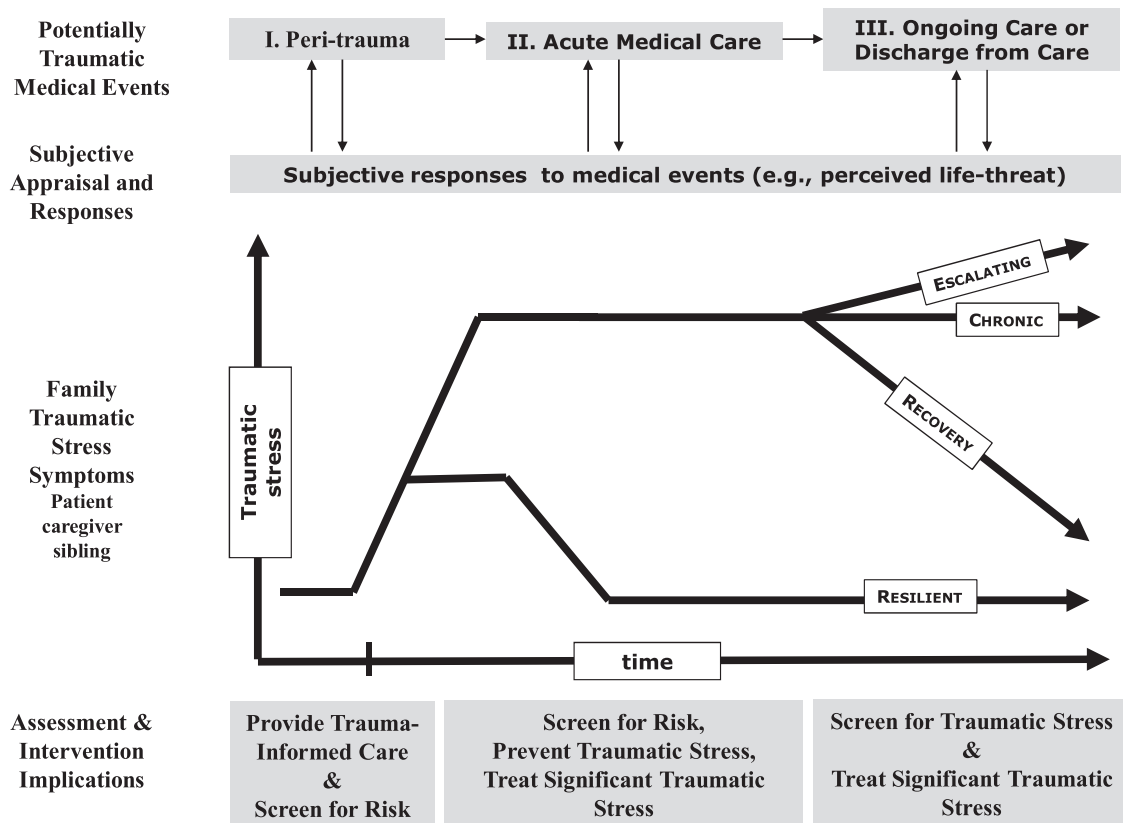
Integrative Trajectory Model of PMTS (see Figure 1). This updated model: (a) highlights that phases of PMTS progress according to the course and timing of medical events and treatment that will vary across various conditions and disorders; (b) confirms subjective appraisals as a powerful risk factor for PMTS; (c) adds empirically supported trajectories of PMTS; (d) reaffirms the competency-based approach to PMTS; (e) emphasizes PMTS within the context of the family; and (f) updates assessment and intervention implications.

The importance of medical events across all phases of the model is now highlighted by renaming the phases as: Phase I. Peri-Trauma, Phase II. Acute Medical Care; and Phase III. Ongoing Care or Discharge from Care. This update places an appropriate emphasis on clinically meaningful changes in medical treatment, which vary by illness and injury. Recent studies suggest that medical events contribute to child and parent PMTS, including new-onset type 1 diabetes, invasive treatments, length of hospitalization, and late effects of cancer treatment. However, psychological reactions to potentially traumatic medical events vary. The relationship between medical events and psychological reactions remains central to the model, and the revised model reaffirms the role of subjective appraisals of medical events as a critical predictor of

PMTS (Brosbe et al., 2011; Kahana et al., 2006). In line with a large body of evidence, children and parents who *perceive* a high risk of life threat, reoccurrence, or complications related to pediatric illness or injury are at greatest risk for PMTS.

Informed by the recent longitudinal studies of PMTS, the updated model proposes possible trajectories of PMTS. Four trajectories—Resilient, Recovery, Chronic, and Escalating PMTS—capture distinct patterns across time. In adding these trajectories to the model, the variability in psychological reactions to pediatric illness and injury is more clearly represented. Many families exhibit a typical and expected level of distress in response to pediatric illness and injury. Inclusion of the Resilient PMTS pathway, which characterizes the majority of families, further highlights the adaptive abilities of most children, parents, and siblings. A smaller proportion of families follows the Recovery pathway and the smallest proportions follow the Chronic or Escalating trajectories. The updated model also more concretely emphasizes the need to consider PMTS among families, including patients, their caregivers, and siblings, as recent studies confirmed the crucial role of the family context.

Finally, advances in the empirical literature allow for updated clinical implications for assessment and



**Figure 1.** Integrative Trajectory Model of Pediatric Medical Traumatic Stress. A schematic of the model includes medical phases and psychological responses to pediatric injury and illness, as well as important risk factor and indicated psychosocial assessment and intervention practices.



intervention. Recent studies indicate greater variability in PMTS across the phases (medical events) of the Integrative Trajectory Model of PMTS and in turn suggest that the appropriate level of intervention for PMTS likely also varies. For example, some families with multiple risk factors, including perception of significant life-threat, preexisting psychological problems, or history of PTE, may require clinical intervention during Phase II (now named Acute Medical Care) rather than Phase III (now named Ongoing Care or Discharge from Care). The updated model thus emphasizes the need for repeated screening/assessment to monitor changes in level of risk and PMTS over time. Level of intervention to prevent or reduce the severity of PMTS, such as universal, targeted, or clinical intervention, should be determined by evaluation of child and parent PMTS and consideration of trajectories of PMTS. Phases of medical events outlined in the model serve as important milestones that indicate need for rescreening.

### Limitations of the Current Literature and Future Directions for Research

Although this literature is marked by some limitations common to research in pediatric psychology more generally (e.g., small samples, variability in timing of assessments, predominant use of checklist, and single-reporter methods), multiple strengths were uncovered including a large number of prospective studies across multiple populations, laboratories, and countries, with some studies conducting follow-up assessments over 10 years. Potential sources of bias included selection and attrition bias. Avoidance symptoms of PTSS may lead those with lower levels of PTSS and/or a different constellation of symptoms to participate and/or remain in longitudinal studies of PTSS. This potential for unrepresentative samples increases risk for underestimating prevalence of PMTS and may affect estimates of relations among risk factors, PMTS, and outcomes. In addition, most studies use standardized questionnaires to assess PTSS, but the field has not yet arrived at consistent common measures, reporters, or timing of assessments for children and parents. There are new areas of research, such as previously understudied pediatric populations and relations among parent and child PMTS, as well as novel analytic approaches to understanding PMTS, notably empirically derived trajectories. These areas and methods are in their infancy and replication and extension is needed.

To move this literature beyond describing the prevalence of, and single risk factors for, PMTS, examinations of mechanisms through which PMTS develops are important. For example, pediatric illness and injury may lead to changes in parenting, which, in turn, may confer risk for child PMTS. Research to date has only begun to examine the most proximal

risks and contexts of child development (i.e., immediate family). Future work in this area would be well-served by focused empirical attention examining the main and interactive effects of the child-specific factors (e.g., biological/genetic factors) and broader contexts of children's lives (e.g., parenting, school, socioeconomic factors).

There is an important opportunity for a stronger developmental focus. To date, empirical consideration of the role of developmental period in PMTS uses chronological age as the sole indicator. More rigorous examinations that explicitly evaluate children's cognitive, social, and emotional development in the context of PMTS research could inform our understanding of how development impacts PMTS. Additional design and evaluation of screening practices and preventive and indicated treatments to meet the needs of preschoolers, school-aged children, and adolescents is needed. Research evaluating the feasibility of these screening and treatment programs in a variety of medical settings could inform directly clinical care for PMTS.

The current model was not developed to fully encompass the experiences of families in which a child dies from illness or injury, thus additional empirical examination is needed regarding the model's applicability for end-of-life care, loss, grief, and traumatic grief in families in circumstances of child death.

### Conclusions

In summary, research on PMTS in pediatric illness and injury has thrived over the past decade. The Integrative Model proposed nearly a decade ago continues to offer a valid and useful framework for understanding traumatic stress responses of patients and families and for anticipating assessment and treatment needs. The revised Integrative Trajectory Model emphasizes the importance of medical events in PMTS and reflects emerging literature identifying trajectories of adjustment over time.

### Supplementary Data

Supplementary data can be found at: <http://www.jpepsy.oxfordjournals.org/>.

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