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Project Title: Long-term mental health outcomes of pediatric surgery patients

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Summary (250 words max single spaced):
Some studies show that trauma symptoms, depression, and anxiety sometimes follow surgery in pediatric patients. Because adverse events in childhood are linked to mental health problems later in life, surgery might have long-lasting effects in pediatric patients. The purpose of the present study was to critically review the literature on mental health outcomes of pediatric surgery patients in order to investigate the relationship between surgery in childhood and postoperative symptoms of trauma, depression, and anxiety. Studies addressing mental health outcomes of pediatric surgery patients (aged 4 to 18 years) published over the past 20 years were searched in Pubmed. A total of 24 studies met the inclusion criteria. Of these, 13 had a long-term follow-up period, defined as two years or more postoperatively. Findings indicated that pediatric surgery patients typically suffered from increased depression and anxiety for several months postoperatively; symptoms then either plateaued or declined over time. Pediatric surgery patients also demonstrated trauma symptoms in both short- and long-term studies. These symptoms tended to persist and did not improve over time. Limitations of this review included relatively few studies with limited follow-up periods, heterogeneity of surgical procedures and diseases, and the participants' health status. In conclusion, this review demonstrated that surgery can be a traumatic experience for children, and that these mental health consequences can persist into adulthood. More long-term research is recommended to provide information for healthcare professionals to better identify those at risk for adverse mental health effects and provide the support needed.

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Long-term mental health outcomes of pediatric surgery patients

Introduction and Background

While medical procedures are designed to treat illnesses successfully, they may also cause unintentional harm to patients due to their painful or invasive nature. Children are particularly susceptible to experiencing mental health issues related to or as a result of medical procedures—surgery in particular. This concern was first identified over 60 years ago by Jackson (1952) in a study where tonsillectomy patients 3 to 8 years of age reported feelings of "anxiety, suspiciousness, resentment, hostility, inadequacy, insecurity, and desire to retaliate" even before the surgical procedure[1], while other early work reported 16% of pediatric surgery patients still had "some degree of emotional handicap" three months post-operatively.[1]

A body of research conducted over the past twenty years has begun to demonstrate that post-operative mental health difficulties such as trauma symptoms, depression, and anxiety can be serious and significant for pediatric surgery patients. The term "pediatric medical trauma" was coined to describe this issue, and is defined 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" which often includes "symptoms of arousal, re-experiencing, and/or avoidance."[2] Postoperative mental health issues can be similar to those of posttraumatic stress disorder (PTSD), defined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as "exposure to actual or threatened death, serious injury, or sexual violence" but which must include at least one intrusion symptom associated with the event such as distressing memories and flashbacks.[3] However, children may experience a variety of challenging mental health difficulties following a medical procedure without ever meeting the criteria for a PTSD diagnosis. Posttraumatic stress symptoms (PTSS) describe a range of emotional reactions such as anger, fear, sadness, and shame as well as maladaptive behaviours such as substance abuse. Physical disorders associated with PTSD and PTSS involve a range of symptoms and illnesses.[4] Over the longer term, chronic pain, hypertension, hyperlipidemia, obesity, and cardiovascular disease have all been associated with PTSD.[5] Other common reactions include internalizing disorders such as anxiety and depression,[6,7] which can persist for varying amounts of time.

Adverse and potentially traumatic events in childhood are linked to later adult mental health problems, such as depression, anxiety and PTSS over the life course.[8] For example, after controlling for potential recent causes of depression, one study found that adverse events in childhood doubled the risk of depression in adults aged 65 and older.[9] Furthermore, evidence suggests that trauma experienced in childhood may lead to more severe symptoms of PTSD than trauma experienced as an adult.[10] Therefore, a better understanding of postoperative mental health issues would not only be useful in preventing mental health difficulties for pediatric surgical patients, but would also help to prevent longer term mental health difficulties over the life course.

The Scope of the Problem

Approximately 450,000 surgeries are performed on pediatric patients each year in the United States.[11] At the Toronto Hospital for Sick Children, over 6,000 inpatient surgeries and over 5,000 day surgery cases were seen in 2008-2009.[12] Given the prevalence of pediatric surgeries, it would seem prudent to carefully investigate the potential risk for post-operative mental health problems such as anxiety, depression, or PTSS, both in the short and the long term.

There is a wide degree of variability in children's response to invasive medical procedures, with most being able to cope effectively and access needed supports.[10] However, a significant minority of children demonstrates mental health difficulties as a response to these procedures. For example, two independent studies modeled short term trajectories of PTSS following injury: one study investigated preschool-aged children with minor unintentional burn injuries while the second investigated school-aged children and youth post-injury.[13,14] Together, these studies suggested four distinct trajectories: resilient (minimal PTSS following injury), recovery (initial PTSS that declined within 1–3 months), chronic (consistently elevated PTSS for 6–24 months post-injury), and delayed onset (new PTSS diagnosis six months post-injury). The majority of children (57–72%) followed a resilient pathway, with fewer children (18-33%) following the recovery trajectory, and the smallest number following the chronic (8-10%) and delayed-onset (2%) patterns. These trajectories are influenced by risk and protective factors, such as the age of the patient at the time of surgery[15], the success of the surgery[15–19], medical factors[20], baseline mental health of the patient[21], and family functioning postoperatively.[15,22–24]

An emerging body of work has examined the short-term mental health effects of pediatric surgery for a variety of illnesses in which follow-up periods range from 3 months to 2 years after the procedure. Only a very few number of studies have followed children over the longer term: however, some evidence suggests that mental health effects of surgery may be longer lasting for some children[8,9]. The purpose of the present review was to critically examine the literature investigating mental health outcomes associated with pediatric surgery published over the past 20 years. The two primary goals were 1) to summarize these outcomes to enhance current pediatric practice, and 2) to identify gaps in the literature to provide an agenda for future research.

Methods

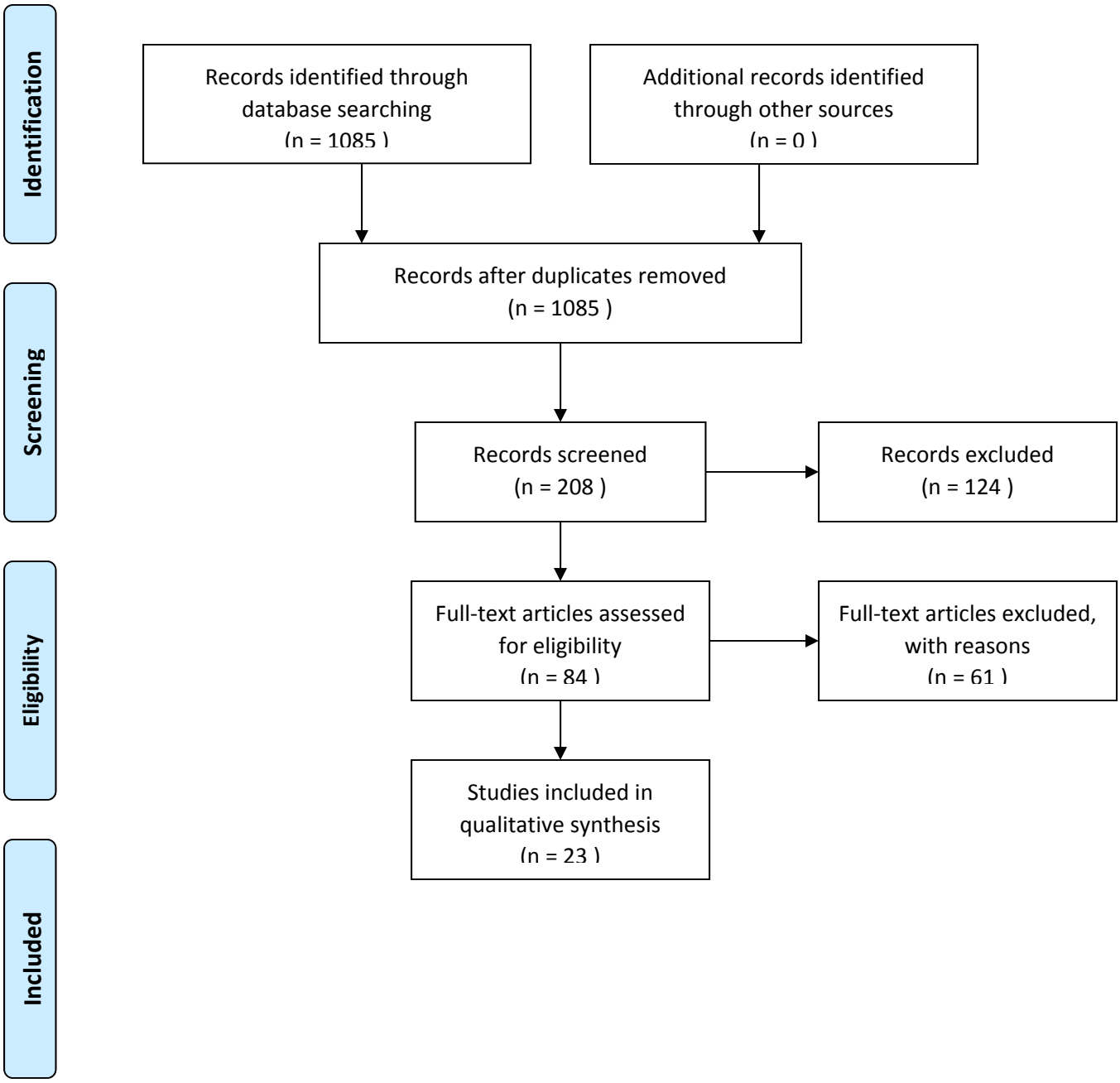
A qualitative review following PRISMA guidelines was undertaken to identify peer-reviewed published research on the mental health outcomes of pediatric surgery patients over the past 20 years. The search included studies published in English from June 1997 to June 2017. Pubmed was searched using the keywords: "general surgery", "surgical procedures", "depression", "depressive disorders", "anxiety disorders", "posttraumatic stress disorders", "traumatic stress disorders", "suicide", "mental health", "mental disorders", "mentally ill persons", "adolescent", "child", "preschool child" and "cohort studies". The initial search identified 1085 studies (see figure 1). Studies addressing postoperative outcomes of trauma, and internalizing disorders such as anxiety and depression, and psychosocial quality of life were included in the search. Studies that measured postoperative outcomes including behavioural problems, ADHD, and cognitive measures were excluded, as were studies on postoperative delirium. Surgeries conducted in the context of intentional or unintentional injuries were also excluded, as the injury event may have caused additional trauma unrelated to the surgery. The age criterion was limited to participants ranging in age from 4 to 18 years of age. However, studies which fell slightly outside this range were included if a small minority of the participants were under 4 or above 18 years of age. Nine studies met these inclusion and exclusion criteria.

Also, 14 studies found from a previous search conducted in June 2016, were added if they met the same criteria. Pubmed keywords used in this search included: "pediatric surgery", "mental health", "traumatic stress disorders", and "psychological trauma".

Out of 23 papers included in this review, several different types of surgery were investigated including five studies addressing organ transplantation, eight concerning bariatric

surgery, and four addressing epilepsy surgery. Three reviews were also included. The remaining types of surgery were tonsillectomy, otoplasty, and surgery for ventricular septal defect. Follow-up periods across studies ranged from three months to 18 years.

Figure 1. June 2017 literature search



Results & Discussion

Short Term Mental Health Outcomes

There were seven studies that investigated short term mental health outcomes for pediatric surgery patients; length of outcome measurement ranged from six weeks following surgery to up to 24 months later. The three main mental health outcomes addressed in the present review were trauma symptoms, anxiety and depression; the latter two being internalizing symptoms. Each of these is discussed below.

Trauma Symptoms. Tonsillectomy and adenoidectomy are still fairly common pediatric surgical procedures[25] for the treatment of sleep-disordered breathing, sleep apnea, and recurrent tonsillitis. A study on tonsillectomy and adenoidectomy patients aged 2 to 7 found that 6 weeks postoperatively, 9.5% of children scored above the cut-off point for intrusion and avoidance on a PTSS scale which "indicated a likelihood of the presence of Post-Traumatic Stress Disorder as described in the DSM-IV."[26] Other work on transplant recipients indicated that elevated rates of psychopathology both before and after surgery were common. Preoperatively, this might be due to the effects of their illness, while postoperatively, this might be due to factors relating to medication, adherence, and recovery. In a study on 104 solid organ transplantation patients aged 12 to 20, 30.7% were "PTSD-symptomatic", which included those who met the full criteria for PTSD and those who fulfilled two out of the three criteria. Trauma symptoms were present in high proportions in pediatric surgery patients in general: 49% experienced avoidance, 38.5% had re-experiencing symptoms, and 25% had arousal symptoms.[20]

Depression & Anxiety. Depression is a common mental health outcome following pediatric surgery. One study found that depression was four times more common in tonsillectomy patients than non-hospitalized children three weeks postoperatively. However, within three months following surgery, signs of depression were no longer detected.[27] In children having undergone heart and heart-lung transplants, levels of depression dropped from 23% at one year to 13% at three years. This end level was not significantly different from the general child population.[28] A smaller study on epilepsy with nine surgery patients aged 8 to 15 years found that levels of anxiety and depression were not significantly different preoperatively; it also found that these levels did not change after the surgery.[29] However, it should be noted that the sample size may have been too limited to capture significant differences.

A "halo effect", or post-operative "honeymoon phase", where patients overestimate the positive effects of a procedure for a period immediately following the surgery, may temporarily obscure any negative outcomes. For this reason, long-term data is needed in order to capture the full impact of the surgery on the patient. For example, in one review, all four studies examining depressive disorders in adolescents undergoing bariatric surgery found decreased levels of depressive symptoms at six and nine months after the procedure.[30] However, in one of these studies there was an increase in depressive symptoms nine months post-surgery.[17] Because most studies in the area of mental health outcomes of pediatric surgery patients are short term, a potential worsening of symptoms after a "honeymoon period" may be missed and this effect may be mistaken for a resilient trajectory.

Figure 2. Summary of studies

Author	Study	N	Follow-up	Outcome measured	Results
Broekman BFP, 2009	The psychological impact of an adenoidectomy and adenotonsillectomy on young children	N=43	6 weeks	PTSS	PTSS were "rare"
Guan G, 2014	Behavioural and emotional outcomes in school-aged children after surgery or transcatheter closure treatment for ventricular septal defect	N=64	mean 5 years	Depression	Internalizing behaviour problems in those undergoing procedures
Herget S, 2014	Psychosocial Status and Mental Health in Adolescents before and after Bariatric Surgery: A Systematic Literature Review	N=227	6 months to 9 years	Anxiety, depression	Depression decrease in 9 months - 1 year followed by an increase in some studies
Jackson K, 1952	Problem of emotional trauma in hospital treatment of children	N=105	18 months	Emotional trauma	17/105 children displayed behavioural issues after 18 months
Järvholm K, 2015	Two-year trends in psychological outcomes after gastric bypass in adolescents with severe obesity	N=88	2 years	Anxiety, depression	Anxiety and depression decreased
Järvholm K, 2012	Short-Term Psychological Outcomes in Severely Obese Adolescents After Bariatric Surgery	N=37	mean 4 months	Anxiety, depression	Anxiety and depression decreased
Kubik JF, 2013	The impact of bariatric surgery on psychological health	N=53	4 months and 2 years	Depression	Decrease in depression
Mintzer LL, 2005	Traumatic stress symptoms in adolescent organ transplant recipients.	N=104	1 to 14.5 years	PTSD	16% met the criteria for PTSD, another 14.4% met 2 out of 3 criteria
Niemelä BJ, 2007	Does leg lengthening pose a threat to a child's mental health?: An interim report one year after surgery.	N=27	1 year	Anxiety, depression	Anxiety and depression decreased
Papakostas K, 2003	Depressive symptoms in children after tonsillectomy	N=159	3 months	Depression	Increased prevalence of depression after 3 weeks, no persisting

					cases of depression after 3 months
Puka, 2015	Predictors of long-term quality of life after pediatric epilepsy surgery	N=109	4 to 11 years	Anxiety, depression	Seizure status was positively linked to levels of anxiety and depression
Sahli, 2009	Two-year trends in psychosocial functioning after adolescent Roux-en-Y gastric bypass	N=16	43 months	Depression	Decrease in depressive symptoms after 1 year followed by a slight increase
Smith ML, 2011	Self-reported symptoms of psychological well-being in young adults who underwent resective epilepsy surgery in childhood	N=98	9 years	Anxiety, depression	Seizure status was positively linked to levels of anxiety and depression
Songu M, 2014	Long-term psychosocial impact of otoplasty performed on children with prominent ears	N=107	24-52 months	Anxiety, depression	Decrease in anxiety and depression
Sysko R, 2012	Psychological outcomes and predictors of initial weight loss outcomes among severely obese adolescents receiving laparoscopic adjustable gastric banding	N=101	15 months	Depression	Levels of depression decreased with the fastest improvement occuring earlier on in the follow up period
Tavares TP, 2015	Emotional functioning: Long-term outcomes after pediatric epilepsy surgery	N=113	4 to 11 years, mean 7.67 years, SD 2.35	Anxiety, depression	Higher levels of anxiety and depression in patients with seizures
Walker AM, 1999	Post-traumatic Stress Responses Following Liver Transplantation in Older Children	N=54	3-27 months (16.94 mean, 7.69 SD)	PTSS	Higher rates of PTSS in patients undergoing surgery for a life-threatening illness
Willcox K, 2014	Biopsychosocial Outcomes of Laparoscopic Adjustable Gastric Banding in Adolescents: a Systematic Review of the Literature	N=453	up to 18 years	Depression	Depression decreased
Williams J, 1998	Cognition and behavior after temporal lobectomy in pediatric patients with intractable epilepsy	N=9	8 years 5 months to 15 years 8 months	Anxiety, depression	Nonsignificant differences in anxiety and depression

Wray J, 2006	Prospective Psychological Evaluation of Pediatric Heart and Heart-Lung Recipients	N=28	2 years	Depression	Improvement in depression scores after surgery
Wray J, 2004	Depression in pediatric patients before and 1 year after heart or heart-lung transplantation	N=58	1 year	Depression	Depression decreased
Wray J, 2006	Longitudinal Assessment of Psychological Functioning in Children After Heart or Heart–Lung Transplantation	N=36	3 years	Depression	Depression decreased
Zeller MH, 2011	Two-year trends in psychosocial functioning after adolescent Roux-en-Y gastric bypass	N=16	2 years	Depression	Decrease in depression after 1 year followed by a slight increase after 2 years

A systematic review by Willcox (2014) on the biopsychosocial outcomes of laparoscopic adjustable gastric banding found one study reporting on depression in adolescent patients: this study reported that psychosocial factors such as depression improved six to 24 months after surgery.[31] Another study found that the improvements in children's depression and anxiety were seen up to 4 months after the surgery.[21] It is unclear, however, to what extent these effects were due to postoperative improvements in physical health, such as weight loss, or to the reduction of comorbidities. Furthermore, adolescent bariatric surgery patients may have high rates of pre-surgery psychological comorbidities, with another systematic review finding that 15 to 70% of these patients displayed depressive disorder symptoms and 15 to 33% reported anxiety disorder symptoms before surgery.[30] A positive reaction to restored or improved physical function might also mask negative mental health effects related to surgery in the short term. For example, anxiety and depression scores were lower for leg-lengthening patients aged 6 to 16 years one year after the procedure.[19]

Summary. Most short-term studies reported the presence of PTSS postoperatively, which did not appear to improve over time. In contrast, depression and anxiety were more often measured both before and after surgery, and did tend to decrease postoperatively. Overall, the studies reviewed revealed that mental health symptoms were common for pediatric patients after surgery. Although there were few studies on trauma (n=3), every one reported PTSS in a significant number of patients. Of these studies, the longest follow-up period was 18 months. Clearly, long-term follow-up of trauma symptoms in pediatric surgery patients is a significant gap in the current literature and would be very useful in determining the ultimate trajectories of these patients.

Long-term studies

For the present review, we defined a long-term follow-up period as two years post-surgery or longer. Only one study investigated long-term trauma symptoms, while 12 studies tracked long term depression and anxiety symptoms for pediatric surgery patients.

Trauma symptoms. One long-term study found no improvement in PTSS post-operatively for children aged 1.2 to 18.3 years. High rates of PTSS were found in children who received liver transplants with a follow-up period ranging from 3 to 27 months. Trauma symptoms were "not influenced by time, suggesting that these symptoms are persistent." This study found that 78% of transplant recipients fell in the mild, moderate, or severe range for posttraumatic stress. Controls, which consisted of children with chronic asthma or those who had undergone routine ears nose and throat operations for non-life-threatening conditions, had considerably lower levels of PTSS. In these groups, 11% were in the mild range with none in the moderate or severe range.[32]

Depression and anxiety. Two studies identified a trajectory where depression and anxiety symptoms increased over time, and then reached a plateau where symptoms either declined or did not change further. For example, one study that investigated pediatric bariatric surgery patients aged 14 to 17 measured depressive symptoms at baseline before surgery, as well as at 18 and 24 months postoperatively. There was an increase in postoperative depressive symptoms at 18 to 24 months, which coincided with weight regain. Overall, most children returned to baseline depressive levels at the two year mark.[33] In another study on bariatric surgery, anxiety and depression in children aged 13 to 18 decreased after one year then remained lower up to two years postoperatively. However, these levels were significantly higher than those of age-matched controls at the two year mark.[34]

Other studies have not followed this pattern. Research on pediatric heart and heart-lung transplant patients showed that 25% of patients who scored above the clinical cut-off on the Child Behaviour Checklist (CBCL) internalizing scale at 6 months, 30% at 12 months, and 28.6% for 24 months postoperatively. These proportions were not significantly different, indicating stability over time.[35] With a follow-up period ranging from 24 to 52 months, one study on children undergoing otoplasty for prominent ears found a statistically significant decrease in anxiety and depression several years postoperatively.[36] In patients receiving cochlear implants, no difference was found in depressive symptoms compared to normal hearing controls 43 months later.[37] An investigation of epilepsy surgery patients assessed 4 to 11 years postoperatively found that depression symptoms, state anxiety, and trait anxiety did not differ at follow-up between treatment and control groups. Instead, surgery outcomes and the health status of the participants were significant predictors of mental health. Patients with seizures had worse depression and anxiety than those without.[38]

Summary. Only one long-term study addressed longer term trauma in pediatric surgery patients. The trajectory reported was similar to short-term research, in which the presence of PTSS did not improve over time. In contrast, several longer term studies on depression and anxiety revealed that these symptoms increased in the short term, but often lessened over time. Overall, these longer term studies suggested that PTSS, depression, and anxiety were associated with surgery. While depression and anxiety symptoms improved over time, some level of PTSS appeared to persist. The degree of success of surgery outcomes predicted depressive symptoms in one study, suggesting that risk and protective factors may be important mediators for mental health outcomes in pediatric surgical patients.

Risk and Protective Factors for Postoperative Mental Health Difficulties

Research has identified risk and protective factors that may influence the mental health outcomes of pediatric surgery patients, including the results of the surgery, medical factors, preoperative mental health status, child age and family factors. These are reviewed below.

Results of surgery. The results of surgery may influence mental health symptoms in pediatric surgery patients, and may sometimes lead to changes in psychosocial functioning, although results are mixed. One long-term study on epilepsy surgery patients with a mean age of 12 years found that depression and anxiety worsened seizure status in patients which in turn worsened their depression and anxiety four to eleven years later.[39] Another study found no difference in depression and anxiety scores of 13 year old patients who had undergone epilepsy surgery and those who had not.[16] Changes in Body Mass Index (BMI) in the first four months after bariatric surgery showed no association with depression and anxiety levels in one study on pediatric bariatric surgery patients.[21] In contrast, changes in BMI in patients after bariatric surgery in aged 14 to 19 were positively correlated with psychosocial measures such as depression and anxiety.[17] It is not clear whether the variability in these results is due to the different medical problems in each study, the age groups studied, or another factor.

Complications arising from surgery may have important repercussions on patients' lives. Subsequent corrective procedures, medical interventions, and loss of time and function related to these complications may foreseeably have an impact on their mental health, which may be long-term. In Guan's 2014 study on ventricular septal defect repair, a postoperative atrioventricular block was a risk factor for worse CBCL total scores combining internalizing and externalizing problems six months later.[15] Conversely, a study by Niemelä (2007) on leg lengthening reported no association between complications and depression and anxiety.[19]

A study by Guan (2014) compared 29 children aged 6 to 13 who underwent surgical repair of a ventricular septal defect to 35 children who underwent transcatheter closure and a control group consisting of their age- and sex-matched best friends. The results showed that children who underwent a procedure had higher levels of depression than controls. The authors proposed that children undergoing surgery faced some hardships negatively impacting their mood and behaviour. For example, pain and discomfort may alter their body image so that they "see themselves as more fragile".[15] Restrictions in daily living and physical activities may exacerbate this, as children may feel excluded from social activities. Poorly healed post-operative scarring, which was found to be a risk factor for negative behavioural changes, may also affect body image.[15]

Medical factors. Medical factors have been shown to be associated with mental health outcomes. A study on organ transplant patients aged 12 to 20 years with a follow up of 1 to 14.5 years found that acute illness onset and the presence of more severe complications were positively associated with higher PTSS.[20] Conversely, psychological functioning was not correlated to medical status at any time during the three-year study period in a another study of heart or heart-lung transplantation patients (ages 1.3 to 15.3).[28] Discrepancies in these results may be due to the nature of the different diseases, or to the small sample sizes and variable length of follow-up of the studies.

One study comparing patients undergoing ventricular septal defect repair surgery with those undergoing transcatheter closure and healthy controls found no significant differences in depression postoperatively in the two groups undergoing procedures, but these patients had higher levels of anxiety than controls.[15] This suggests that the level of invasiveness of the procedure did not affect the mental health outcome of depression in this study.

Preoperative mental health status. Children who require surgery tend to have worse mental health, and more anxiety and depression, as well as worse scores on mental health questionnaires compared to healthy children their age.[8,15,20,30,36,37,40,41] This may be due to the effect of their illness on their activities, such as loss of social interaction due to missing school,

the stress of having an illness or of the perception of being seen as different because of their illness. Some diseases such as epilepsy, are themselves associated with mental health problems in childhood.[41] Other conditions have cosmetic components that could lead the child to being self-conscious or getting teased by peers about their appearance.

Cosmetic concerns may affect a child's social life and their self-esteem. Surgical correction can have a positive effect on these, which may attenuate the potentially traumatic experience of the surgeries. One study on leg lengthening in 27 patients (ages 6-16) found a reduction in anxiety and depression one year later, with no difference in self-esteem compared to controls postoperatively.[19] Alternatively, poor mental health before surgery was a predictor of poor mental health postoperatively in studies on both scoliosis treatment and bariatric surgery.[21] Children undergoing otoplasty for protruding ears had very high levels of psychopathology preoperatively: over half (53%) of patients in a recent study were referred to surgery from a pediatric psychiatry clinic. "Low self-esteem, general lack of self-confidence and social isolation are among the reasons why parents of affected children opt for otoplasty."[36] Postoperatively, there was an improvement in CBCL scores for a number of scales including anxiety and depression. It is possible that the cosmetic repair led to these changes as a result of improved self-confidence and a reduction in bullying experienced by these children.

Some diseases involve social, emotional, or physical factors that may affect the course of mental health symptoms following pediatric surgery. Most of the recent studies relating to mental health effects of pediatric surgery focused on one disease, which may have its own unique influence on these symptoms. Effects of the disease itself or its comorbidities may increase the negative mental health effects that are observed. For instance, 48% of epilepsy patients reported a history of psychological problems before surgery in one study.[16] Epilepsy is known to be associated with a higher incidence of psychiatric symptoms in children.[42–45] These psychological disturbances of childhood are correlated with psychiatric disorders in adulthood.[16] This is potentially an important confounding factor in studies involving epilepsy patients.

Age. Mixed results were found concerning the impact of age on the mental health of pediatric surgery patients. Age was not a predictor of depression in a study on heart or heart-lung transplantation (ages 8-17)[40], or on trauma symptoms in another on liver transplantation (ages 7-17).[32] However, age was included as a risk factor for internalizing problems such as depression and anxiety in a study on treatment for ventricular septal defect (ages 6-13).[15] The follow-up periods were generally from 6 months to 1 year, except in this last study, which had a median follow up time of 18 months but with quite a variable period ranging from 4 months to 16.5 years. The sample sizes were all small, ranging from 18 to 66 participants. These limitations, along with the effect of the different health conditions, may be the causes of the discrepancies between the results of the studies.

Family factors. Parents of children undergoing surgery are themselves at risk of developing PTSS and PTSD. In a study by Rossi (2011), 52% of mothers and 40% of fathers whose child had undergone transplantation met the criteria for PTSD. A further 13% of mothers and 12% of fathers had PTSS.[46] Another study found PTSD in 20% of mothers whose child had undergone surgery to repair a congenital defect.[47]

There is a good deal of evidence to suggest that parents' distress can be communicated to their children. The existence of psychological symptoms in the parents, such as anxiety, has been correlated with worse mental health outcomes in the child.[48] For example, maternal

anxiety was the strongest risk factor for poor mental health outcomes six months later in 29 children with ventricular septal defect.[15]

Parents' anxiety and PTSS in response to their children's medical trauma may increase these symptoms in their child.[48] Studies of interventions aimed at reducing parental anxiety showed that this has a beneficial effect on the child as well.[22] Consequently, interventions aimed towards the parents may have a beneficial effect on the patient. For example, an interaction between the mother and a nurse who helped her address questions and concerns regarding the surgery was found to lessen the child's negative response to the surgery.[49] More research is needed on both the effects that parents' distress has on their children as well as on interventions to reduce this stress, as parents represent another avenue by which future mental health problems may be mitigated in pediatric patients.

Limitations

There were important limitations to the studies that were reviewed, and to the present review itself. Many studies had small samples sizes which were affected by losses to follow-up and patient deaths. Furthermore, the wide ranges of ages in many samples may have precluded the ability to detect developmental effects[49,50] For example, some studies included a sample of patients ranging from preschool age to young adulthood at the time of surgery or follow-up. Occasionally, the questionnaires used were not validated for all ages in the sample, making it difficult to compare results objectively.

Most of the studies reviewed measured short-term outcomes within 24 months following surgery. However, it is known that PTSD can manifest years after the initial trauma.[8,9] Therefore, It is unclear whether shorter time periods were adequate to capture mental health difficulties. Longer-term data is needed to determine the effects of pediatric surgery beyond childhood and adolescence throughout the life course. Other studies used variable follow-up periods, which might have obscured differing trajectories that may exist, particularly when the range of follow-up was very broad. Mental health status might depend on the time frame and vary in a single person from the third month postoperatively to five years later, for example.

Some studies had no control group. In those cases, it was more difficult to determine whether a change in mental health was due to the medical cause for surgery, developmental changes, or to the trauma of surgery. Similarly, some studies did not measure mental health preoperatively or establish a baseline. In some cases, this was due to the patient being too young to answer a patient-reported questionnaire. Unfortunately, parental report or observational measures were not employed. It is not known whether those patients had pre-existing mental health conditions, or if their temperament might have had an impact on their later outcomes.

Heterogeneity within treatment groups was also a limitation in a number of studies. Some included children undergoing different surgeries, and others included those with different underlying pathologies, all of which might have had an impact on mental health outcomes. Additionally, the use of psychotropic drugs was often not reported. The use in itself of these medications may have a confounding effect on their mood and mental health status. This is particularly relevant in the epilepsy studies, as many of the children were taking one or many antiepileptic drugs, which are known to have effects on mood.

Some studies used various measures of quality of life that were beyond the scope of this paper. In the future, a review of these outcomes may identify additional insights into the mental health of pediatric surgery patients.

Limitations of the present review included searching Pubmed only, focusing on three mental health outcomes only, and having only one reviewer read and appraise the literature.

Future Directions

Based on the findings of the present review, more long-term studies are clearly needed to capture potential negative mental health effects of surgery which may manifest after the postoperative "honeymoon period" has ended. Likewise, work focused on why depression and anxiety improve in most patients over time, while PTSS persists in some, might provide healthcare professionals and parents a better understanding of who may benefit from support and how to provide it. Research that systematically measures developmentally appropriate preoperative mental health and follows postoperative monitoring of pediatric surgery patients for more than 24 months may be vital to identifying individuals at risk.

Posttraumatic Growth. Posttraumatic growth (PTG) may occur along with or instead of PTSS following a traumatic event. PTG was positively associated with PTSS in short term studies on pediatric surgery patients aged 11 to 21 years.[51,52] In a study of adolescent childhood cancer survivors, 84.7% reported "at least one positive consequence" of their experience with cancer.[51] Older age and shorter time since diagnosis were associated with PTG.[52,53] In one study, this manifested primarily through a "changed sense of self and perspective on social relationships", which were reported immediately after treatment by a majority of patients.[51] This body of work underlines the importance of noting the prevalence of pediatric surgery patients who do not report mental health difficulties following medical procedures. A greater understanding of the factors affecting the development of PTG may one day be used to influence the recovery trajectories of pediatric surgery patients in a way that maximizes the mental health benefits of the surgery.

Quality of life. Some studies used various measures of quality of life that were beyond the scope of this paper. In the future, a review of these outcomes may identify additional insights into the mental health of pediatric surgery patients.

Planned vs Unplanned Procedures. It is important to distinguish between children who experience planned procedures, such as cholecystectomy patients, and unplanned procedures, such as appendectomy patients, as this may have a significant impact on mental health outcomes. To our knowledge, no data is available on the trauma or mental health effects caused by planned versus unplanned surgeries in children. Unplanned procedures may be more traumatic, and have more serious and longer mental health consequences than planned procedures, in which patients may benefit from support services offered by hospitals and clinics.[54,55] Therefore, we suggest that more research is needed to bridge the gaps in this field.

Conclusion

Surgery can be a traumatic event for children, and mental health consequences can persist into adulthood. To date, most research has focused on short-term outcomes and recovery trajectories within a two-year period. The long-term studies, defined as those that include a follow up period of two years or more, which also measured the outcomes of anxiety,

depression, and PTSS were virtually non-existent. Furthermore, they were limited to bariatric surgery, epilepsy surgery, and organ transplantation. There is an urgent need for research on mental health effects of surgeries for other, in some cases more common, diseases. In particular, unplanned procedures such as appendectomy lack data in this area.

A number of predictors of postoperative mental health difficulties such as anxiety and depression have been identified, but these studies have again relied on short-term data as well as small sample sizes. A prospective longitudinal approach would provide the opportunity to identify better those affected by lasting mental health problems so that future patients can benefit from preventive efforts. For example, planned surgeries allow for more time to prepare and offer the opportunity for interventions which have been shown to improve outcomes, such as giving the child and the parents information about the procedure before it occurs.[54,55]

The present review spanned a 20-year time frame, which was necessary in order to obtain a sufficient number of studies for review. The fact that such a long period was needed highlights the lack of research in this area. Long-term data will allow us to identify better those affected by lasting mental health problems so they may be offered the treatment they require. As Jackson wrote in 1952: “Even as threatening an incident as hospitalization and surgery is merely another feeling-experience. It is the combined responsibility of parents, physicians, and hospital personnel to make it a constructive experience or at least to keep its emotional damage to a minimum.”[1]

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