



# Post-traumatic stress in the postoperative period: current status and future directions

## Stress post-traumatique en période postopératoire : état de la situation et orientations futures

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### Abstract

**Purpose** This narrative review summarizes the current literature on postoperative traumatic stress, namely post-traumatic stress disorder (PTSD), including defining features, epidemiology, identification of patient and perioperative risk factors, assessment tools, intervention recommendations, and future directions.

**Principal findings** Postoperative traumatic stress occurs in approximately 20% of patients following surgery, with additionally elevated rates in specific surgical groups. Potential risk factors include the perceived uncontrollable nature of high-risk surgery, psychiatric history, intraoperative awareness, dissociation, surgical complications, medication administration, delirium, and pain. PTSD after surgery may manifest in ways that are

distinct from traditional conceptualizations of PTSD. Identification of perioperative risk factors and stress symptoms in the early postoperative period may provide opportunities for intervention.

**Conclusion** Research on postoperative traumatic stress, including PTSD, is in its infancy. Current evidence shows elevated incidence rates of postoperative traumatic stress, which can worsen overall physical and mental health outcomes. Future research on assessment, prevention, and treatment is warranted.

### Résumé

**Objectif** Ce compte rendu narratif résume la littérature actuelle sur le stress traumatique postopératoire, soit l'état de stress post-traumatique (ESPT, PTSD en anglais),

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notamment ses caractéristiques déterminantes, son épidémiologie, l'identification des facteurs de risque périopératoires et de ceux liés au patient, les outils d'évaluation, les recommandations d'intervention et les orientations futures.

**Constatations principales** *Le stress traumatique postopératoire survient chez environ 20 % des patients après une chirurgie, et les taux sont plus élevés dans certains groupes chirurgicaux spécifiques. Les facteurs de risque potentiels comprennent la nature inhérente perçue comme incontrôlable des chirurgies à risque élevé, des antécédents psychiatriques, le réveil peropératoire, la dissociation, les complications chirurgicales, l'administration de médicaments, le delirium et la douleur. À la suite d'une chirurgie, un ESPT peut prendre des formes distinctes des présentations typiques de l'ESPT. L'identification des facteurs de risque périopératoires et des symptômes de stress en période postopératoire précoce pourraient permettre d'intervenir adéquatement.*

**Conclusion** *La recherche sur le stress traumatique postopératoire, y compris l'ESPT, en est à ses balbutiements. Les données probantes actuelles témoignent de taux d'incidence élevés de stress traumatique postopératoire, lesquels peuvent détériorer les pronostics globaux de santé physique et mentale. Des recherches futures sur l'évaluation, la prévention et les traitements sont nécessaires.*

Trauma-related disorders among civilian populations, most notably post-traumatic stress disorder (PTSD), are increasingly reported.<sup>1,2</sup> There has been growing interest in understanding PTSD in the context of healthcare events. Research has found clinically significant PTSD symptoms following cardiac events,<sup>3-5</sup> admittance to the intensive care unit (ICU),<sup>6,7</sup> and in the postoperative period.<sup>8-18</sup> With respect to the latter, given that over 230 million major surgeries occur worldwide annually,<sup>19</sup> it is essential to understand the current state of knowledge of post-traumatic stress symptoms, including PTSD, following surgery.

Advances in healthcare have led to higher survival rates following trauma, surgery, and critical illness<sup>20</sup>; survivorship that may be complicated by disordered psychological well-being. Although most adults will recover from illness without incident, between 12 and 25% will develop negative post-traumatic reactions such as PTSD.<sup>21</sup> Despite this, there is a paucity of research devoted to the emotional health and outcomes of surgical patients. It is unclear why surgery is a risk factor for PTSD, but evolving research in other contexts provides clues. The

primary aim of this narrative review is to identify the defining features, epidemiology, and risk factors of PTSD that manifest during the postoperative period. Secondary aims are to identify trauma-related assessment tools appropriate for the surgical population, review potential interventions, and recommend avenues for future research.

## Literature search

We searched the PubMed database to identify published manuscripts from 1993 to 2018 that are relevant to post-traumatic stress and PTSD in medical and surgical populations. Search terms combined “PTSD” and “posttraumatic stress” or “post-traumatic stress” with the following surgery-related terms: surgery, ICU, critical care, cardiac, and intraoperative awareness. We also searched for “anesthetic awareness”, “intraoperative awareness”, “awareness during anesthesia”, “delirium”, and “postoperative delirium”, and we combined the term “surgery” with “amnesia” and “awareness”. Criteria for inclusion were scientific peer-reviewed publications written in English. These search criteria yielded 42 publications *specifically* on postoperative traumatic stress that were included in this review. Related research was included where applicable.

## Defining features of postoperative traumatic stress including PTSD

PTSD is included in the Trauma and Stressor-Related Disorders<sup>22</sup> section of the Diagnostic and Statistical Manual of Mental Disorders - 5<sup>th</sup> Edition (DSM-5). A diagnosis of PTSD requires exposure to a traumatic or stressful event; such events are defined by exposure to “actual or threatened death, serious injury, or sexual violence” p. 271.<sup>22</sup> In this context, the onset of disease requiring surgical treatment or the surgery itself can be seen as “threatened death” or “actual or threatened serious injury.” PTSD is characterized by a constellation of symptoms that must be present for more than one month following a traumatic event. These symptoms include intrusions (e.g., flashbacks, nightmares), avoidance (e.g., avoiding thoughts and situations that are reminders of the event), negative alterations in cognition and mood (e.g., depressive symptoms, maladaptive thoughts), and alterations in arousal and reactivity (e.g., hypervigilance, irritability, sleep disturbance) that cause clinically significant distress and/or functional impairment. An individual experiencing these symptoms *within* the first month of the traumatic experience would be initially diagnosed with acute stress disorder.<sup>22</sup>

PTSD following surgery is typically assessed using the DSM-5 criteria outlined above. There is controversy regarding whether PTSD stemming from an adverse health event differs from more traditional forms of PTSD arising from events such as military combat and sexual or physical assault.<sup>21</sup> Health-related thought intrusions may be future-oriented (e.g., fear of worsening health trajectory), arousal symptoms may be keyed to internal somatic triggers (e.g., pain), and behavioural avoidance may be difficult or impossible.<sup>21</sup> The majority of research in this area has been limited to individuals with cancer, cardiovascular disease, and the critically ill.<sup>7,23,24</sup> If symptoms consistent with illness-induced PTSD are aligned with presentations of PTSD after surgery, assessment tools discussed later in this review may be inadequate. Some argue that postoperative traumatic stress symptoms should be conceptualized on a continuum of severity that may or may not meet diagnostic criteria for PTSD.<sup>25</sup> This assessment may be more appropriate given that illness-induced PTSD may be associated with fewer symptoms.<sup>26</sup> The concept of sub-threshold PTSD, also referred to as sub-syndromal PTSD, is garnering increasing attention. For example, a study of women undergoing emergency Cesarean deliveries found 76% perceived this event as traumatic, 52% endorsed at least one other PTSD criterion, and 33% showed clinically significant intrusive stress reactions one to two months postpartum. None, however, met standard diagnostic criteria for PTSD but approximately a quarter of the full sample were deemed to be in need of psychological treatment.<sup>18</sup> Sub-threshold manifestations of post-traumatic stress are associated with negative psychological and functional outcomes in primary care,<sup>27</sup> veteran,<sup>28</sup> and medical<sup>29</sup> populations.

### Epidemiology of postoperative traumatic stress

Relatively few studies have focused on rates of post-traumatic stress following surgery. Approximately 20% of individuals in a cohort of mixed medical and surgical critical care populations experienced clinically significant clinician-diagnosed post-traumatic stress symptoms in the year following ICU discharge.<sup>30</sup> A multicentre matched double-cohort study found that one in five of participants who completed the DSM-IV version of the PTSD Checklist experienced clinically significant PTSD symptoms directly attributed to their surgery or hospitalization.<sup>8</sup> Nevertheless, when using the self-reported PTSD Checklist and clinician-assessed criteria based on the Mini-International Neuropsychiatric Interview, 8.7% met criteria for probable PTSD.<sup>8</sup> Elevated rates of PTSD symptoms following surgery have also been shown in smaller clinical studies in specific surgical groups such as

elective spinal arthrodesis (19%),<sup>14</sup> lung resection for suspected cancer (51%),<sup>11</sup> bone marrow transplants for breast cancer (19%),<sup>31</sup> abdominal aortic surgery (18%),<sup>12</sup> abdominal surgery for peritonitis (24–38%),<sup>32</sup> and following medical-surgical intensive care (16%).<sup>33</sup> Taken together, this research suggests that although rates of PTSD symptoms may be higher in particular surgical populations (e.g., lung resection for suspected cancer), perioperative research generally shows that rates of clinically significant PTSD symptoms are upwards of approximately 20%. These rates are substantially higher than the 6.8% lifetime<sup>34</sup> and 3.5% past-year<sup>35</sup> estimates of PTSD among the general population.

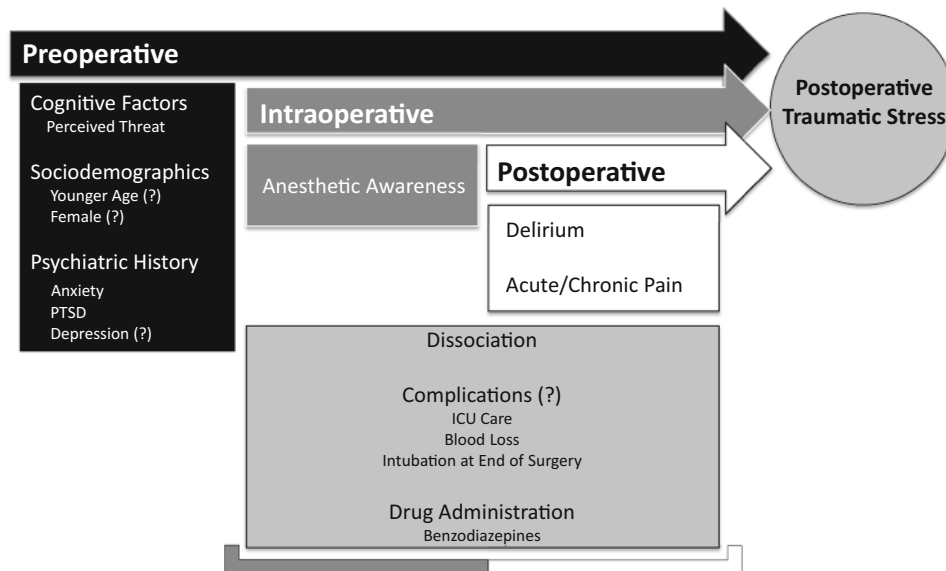
The time course of PTSD following surgery has been examined in a small body of literature with mixed results. Some studies show increases in the prevalence of PTSD throughout the first year after surgery,<sup>10,14</sup> while others have shown stability<sup>33</sup> or decline<sup>13</sup> in symptoms during this period. Further, other studies show variability across time. For example, among a cohort of patients who underwent elective lumbar arthrodesis, the prevalence of postoperative PTSD increased from 7.5% at six weeks postoperatively, to 13.6% at nine months, and to 11.0% at one year postoperatively.<sup>14</sup> Studies also suggest that once PTSD symptoms are established following medical events, they may persist for some time. For example, a study examining PTSD in medical and surgical ICU patients noted a 20% incidence of PTSD symptoms lasting a median of 30 months following the onset of critical illness.<sup>36</sup> The heterogeneity of patients included in these reports makes direct comparisons among them difficult. Nevertheless, the emerging literature suggests that post-traumatic stress may manifest in a considerable number of surgical patients and that it can persist for months or years following surgery.

### Risk factors for postoperative traumatic stress

Below we summarize the factors implicated in postoperative traumatic stress. Evidence regarding each factor may be conflicting and some factors may occur at various points throughout the perioperative period and be independent or act synergistically. The Figure provides a graphic summary of the risk factors, their exposure, and the strength of evidence supporting their role in the development of postoperative traumatic stress.

### Type of surgery and cognitive factors relating to the nature of surgery

Events that are perceived as uncontrollable are associated with higher rates of post-traumatic reactions.<sup>37</sup> Although



**Figure** Perioperative factors implicated in postoperative traumatic stress and PTSD. These factors have been identified as risk factors of postoperative traumatic stress and PTSD in prior research. Factors that include a “?” represent factors where findings were non-conclusive

elective surgery is a choice based on informed consent, many forms of surgery are emergent and all surgeries include risk and loss of autonomy. High-risk surgeries with low levels of perceived control may be associated with particularly high rates of postoperative traumatic stress. As indicated, a study examining lung resection for possible cancer found that over half of patients were at high risk of PTSD three months following surgery<sup>11</sup> and surgery for more advanced cancer was associated with the highest risk of PTSD in women undergoing surgery for gynecologic cancer or benign conditions.<sup>13</sup> Eighteen percent of patients undergoing abdominal vascular surgery were found to have clinician-reported PTSD,<sup>12</sup> while 24–38% of patients who underwent abdominal surgery for peritonitis, a high-risk procedure, reported elevated PTSD symptoms.<sup>32</sup> Relatedly, a history of previous, similar surgery, which may increase perceived degree of threat, was predictive of self-reported postoperative PTSD among those undergoing lumbar arthrodesis.<sup>10</sup> In sum, the perceived degree of threat may be more important than the type of surgery. Our group found no differences between cardiac and non-cardiac surgeries but the perceived degree of threat was significantly associated with PTSD.<sup>8</sup>

### Sociodemographic characteristics

Studies evaluating the association between sociodemographic factors and postoperative PTSD symptoms have yielded conflicting results. Our matched

cohort multicentre study found neither sex nor age were predictive of postoperative PTSD.<sup>8</sup> Conversely, other research has found that younger age is associated with postoperative clinician-diagnosed PTSD in surgical and ICU patients.<sup>12,20,38</sup> These latter studies are consistent with research among non-medical populations that have identified a relationship between younger age and PTSD.<sup>39</sup> Further, females in non-medical settings<sup>2,39</sup> and in the ICU<sup>20</sup> were found to be at higher risk of PTSD than males. Discrepant findings for sex may partly relate to how PTSD following surgery is defined. Although PTSD using a traditional conceptualization is more prevalent in females,<sup>22</sup> recent research by our team suggests a female to male prevalence ratio closer to 1:1 for illness-induced PTSD specifically.<sup>27</sup>

### Preoperative psychiatric disorders

There is also some contradicting evidence in the association between pre-existing psychiatric illness and postoperative PTSD. The majority of research indicates that a history of psychiatric disorders including depression and anxiety, and past PTSD symptoms can be risk factors for clinically significant postoperative traumatic stress including PTSD.<sup>8,10,11,14,40</sup> Moreover, a history of treatment for mental health disorders is associated with postoperative PTSD.<sup>8</sup> Conversely, in one study examining older adults undergoing non-cardiac surgery using general anesthesia, preoperative depression was found to *protect*

against clinically significant self-reported PTSD symptoms three months following surgery.<sup>15</sup> It is possible that emotional numbness in those with depression may mitigate the risk of physiological and emotional stress post-surgery, or perhaps an age effect exists in these relationships, but this requires further investigation.

### Accidental awareness during general anesthesia

Approximately one in 19,000 surgeries worldwide may be complicated by intraoperative awareness with explicit recall.<sup>41</sup> This can represent a highly distressing experience for patients that can range in severity from vague auditory recall lasting a few minutes, sensations of paralysis, memories of difficulty breathing, to the experience of explicit memories of severe pain. Studies report that 20–70% of those with intraoperative awareness report symptoms of postoperative traumatic stress, including helplessness, anxiety, panic, and fears of impending death.<sup>16,17,42,43</sup> There is a growing body of evidence suggesting that intraoperative awareness, perceived as life-threatening, can increase the risk for postoperative traumatic stress including PTSD in both the short and long-term.<sup>8,9,16,43,44</sup> Patients who experienced intraoperative awareness with the sensation of paralysis were more likely to report distress regardless of whether or not they were also in pain.<sup>45</sup> Almost all patients in the Anesthesia Awareness Registry who reported intraoperative awareness indicated that this involved the sensation of paralysis, with 93% indicating this caused them significant distress.<sup>46</sup>

### Postoperative delirium

Postoperative delirium is a neuropsychiatric disorder in the DSM-5<sup>22</sup> characterized by a combination of features including acute onset, fluctuating course, inattention, confusion, impaired orientation, and fragmented memories. Delirium in the context of critical illness or a medical crisis is associated with PTSD.<sup>47,48</sup> Proposed mechanisms linking delirium to PTSD suggest a mediating role of hallucinations and delusions experienced during delirium.<sup>20,47</sup> Overlapping features in the neurocircuitry of the amygdala have been identified in both delirium and PTSD.<sup>49</sup> In addition, prior research has found evidence of PTSD as an independent predictor of emergence delirium, after adjusting for other pre-existing psychiatric disorders.<sup>50</sup> These studies provide support for a potential bidirectional association and possible overlapping features between postoperative traumatic stress and delirium.

### Dissociation

Dissociation in the context of PTSD has gained considerable interest, particularly since the release of the DSM-5<sup>22</sup> which now includes a dissociative subtype of PTSD indicated by the presence of depersonalization (i.e., feeling that oneself is not real) and derealization (i.e., feeling as if the world is not real). Dissociation results in fragmentation of the typical integrated functions of consciousness impacting memory, identity, emotion, perception, body representation, motor control, and behaviour.<sup>51</sup> Peritraumatic dissociation outside of surgery has been identified as one of the most influential peritraumatic risk factors for PTSD,<sup>52-55</sup> and this subtype is associated with more severe post-traumatic stress symptoms and increased psychiatric comorbidity compared with PTSD alone.<sup>56,57</sup>

The experience of peritraumatic dissociation at ICU discharge was found to predict clinically significant self-reported post-traumatic stress symptoms in patients with chronic obstructive pulmonary disease.<sup>58</sup> Dissociation has also been found to be an independent predictor of PTSD in surgical contexts, and has been described in one study as a mediator between intraoperative awareness and PTSD.<sup>8</sup> The relationship between intraoperative awareness and dissociation in surgery may be explained by perceived physical threat, as this has been found to be an important feature characterizing dissociative outcomes in PTSD literature.<sup>59</sup> The experience of delirium and accompanying fragmented delusions and hallucinations of life-threatening events while in a delirious state also may facilitate dissociation. A relationship between post-ICU memories of psychotic experiences or delusional states and clinically significant post-ICU PTSD is also well established.<sup>20,47,60-62</sup>

### Complications

Research examining perioperative complications and postoperative traumatic stress are inconclusive. Some studies suggest that ICU care, longer duration of inpatient care, or perioperative complications have no relation to postoperative traumatic stress.<sup>8,12</sup> Conversely, ICU stay,<sup>32</sup> ICU complications<sup>14,63</sup> and surgical blood loss<sup>12</sup> have been associated with postoperative traumatic stress.

### Drug administration

Research on drug administration and postoperative stress is in its infancy. A systematic review among ICU patients,<sup>64</sup> a meta-analysis among non-medical

**Table** Proposed postoperative traumatic stress assessment strategies

	No. of items	Duration (min)	Advantages	Disadvantages	Scale copy
Face-to-face structured interviews					
Clinician-Administered PTSD Scale for DSM-5 (CAPS-5)	20	40–60	<ul style="list-style-type: none"> <li>-“gold standard” for DSM-5 PTSD assessment</li> <li>-can assess past month and lifetime PTSD</li> <li>-able to assess past week PTSD symptoms</li> <li>-assesses contextual information (e.g., symptom onset/duration, impact of symptoms on functioning, symptom improvement, overall severity, response validity)</li> <li>-also includes items to assess dissociative subtype of PTSD</li> </ul>	<ul style="list-style-type: none"> <li>-time consuming</li> <li>-requires administration by trained professional</li> </ul>	Request copy from the National Center for PTSD <a href="http://www.ptsd.va.gov/professional/assessment/adult-int/caps.asp">http://www.ptsd.va.gov/professional/assessment/adult-int/caps.asp</a>
PTSD Symptom Scale Interview for DSM-5 (PSSI-5)	24	30	<ul style="list-style-type: none"> <li>-allows diagnosis of PTSD in accordance with DSM-5 criteria</li> <li>-assessment of symptom severity</li> <li>-validated against CAPS-5</li> </ul>	<ul style="list-style-type: none"> <li>-requires administration by trained professional</li> </ul>	<a href="http://supp.apa.org/psycarticles/supplemental/pas0000259/z1t004153008so1PDF.pdf">http://supp.apa.org/psycarticles/supplemental/pas0000259/z1t004153008so1PDF.pdf</a>
Acute Stress Disorder Structured Interview (ASDI)	19	5–10	<ul style="list-style-type: none"> <li>-brevity</li> <li>-allows diagnosis of ASD</li> <li>-only structured clinical interview validated against DSM-IV criteria for ASD</li> </ul>	<ul style="list-style-type: none"> <li>-requires administration by trained professional</li> </ul>	Available for members of the International Society for Traumatic Stress Studies <a href="http://www.istss.org/assessing-trauma/acute-stress-disorder-structured-interview-(asdi).aspx">http://www.istss.org/assessing-trauma/acute-stress-disorder-structured-interview-(asdi).aspx</a>
Self-report measures (PTSD)					
Primary Care PTSD Screen for DSM-5 (PC-PTSD-5)	5	2	<ul style="list-style-type: none"> <li>-brevity</li> <li>-easy to administer and interpret</li> <li>-designed for use in primary care settings</li> </ul>	<ul style="list-style-type: none"> <li>-does not provide definitive diagnosis of PTSD</li> <li>-main goal is to screen individuals</li> </ul>	<a href="https://www.ptsd.va.gov/professional/assessment/documents/pc-ptsd5-screen.pdf">https://www.ptsd.va.gov/professional/assessment/documents/pc-ptsd5-screen.pdf</a>
PTSD Checklist for DSM-5 (PCL-5)	20	5–10	<ul style="list-style-type: none"> <li>-can provide <i>provisional</i> PTSD diagnosis</li> <li>-brevity</li> <li>-can be used to monitor symptom change during and following treatment</li> <li>-validated for continuous symptom severity scoring</li> </ul>	<ul style="list-style-type: none"> <li>-main goal is to screen individuals</li> </ul>	<a href="https://www.ptsd.va.gov/professional/assessment/documents/PCL-5_Standard.pdf">https://www.ptsd.va.gov/professional/assessment/documents/PCL-5_Standard.pdf</a>
Impact of Events Scale-Revised (IES-R)	22	5–10	<ul style="list-style-type: none"> <li>-now includes items that assess hyperarousal</li> <li>-mean subscale scores are comparable to the Symptom Checklist 90 – revised (SCL-90-R)</li> </ul>	<ul style="list-style-type: none"> <li>-cannot be used to diagnose PTSD</li> <li>-based on DSM-IV criteria</li> </ul>	Request copy from the National Center for PTSD <a href="https://www.ptsd.va.gov/professional/assessment/adult-sr/ies-r.asp">https://www.ptsd.va.gov/professional/assessment/adult-sr/ies-r.asp</a> <a href="https://www.aerztenetz-grafschaft.de/download/IES-R-englisch-5-stufig.pdf">https://www.aerztenetz-grafschaft.de/download/IES-R-englisch-5-stufig.pdf</a>
Post-traumatic Stress Syndrome Questionnaire (PTSS-10; PTSS-14)	10-14	5–10	<ul style="list-style-type: none"> <li>-brevity</li> <li>-designed for use with ICU patients</li> </ul>	<ul style="list-style-type: none"> <li>-cannot be used to diagnose PTSD</li> <li>-based on DSM-IV criteria</li> </ul>	N/A
Self-report measures (acute stress)					
Stanford Acute Stress Reaction Questionnaire (SASRQ)	30	N/A	<ul style="list-style-type: none"> <li>-significantly shorter compared with the preliminary version</li> </ul>	<ul style="list-style-type: none"> <li>-based on DSM-IV criteria</li> </ul>	<a href="http://stresshealthcenter.stanford.edu/research/documents/GenericversionofSASRQ-30ASDitems.pdf">http://stresshealthcenter.stanford.edu/research/documents/GenericversionofSASRQ-30ASDitems.pdf</a>

Table continued

	No. of items	Duration (min)	Advantages	Disadvantages	Scale copy
Acute Stress Disorder Scale (ASDS)	19	N/A	-designed as a self-report version of the ASDI -predictive of PTSD symptoms	-based on DSM-IV criteria	<a href="https://www.ncbi.nlm.nih.gov/umc/ident/oclc.org/pubmed/10752364">https://www.ncbi.nlm.nih.gov/umc/ident/oclc.org/pubmed/10752364</a>

ASD = Acute Stress Disorder; DSM = Diagnostic and Statistical Manual; N/A = not applicable/information unavailable; PTSD = post-traumatic stress disorder

patients,<sup>65</sup> and a randomized-controlled trial among veterans<sup>66</sup> all suggest that benzodiazepine exposure increases the risk and severity of PTSD. Other drug studies have found no difference in self-reported PTSD symptoms in patients who received midazolam,<sup>67</sup> dexamethasone,<sup>68</sup> or ketamine.<sup>69</sup>

### Postoperative pain

Pain is a complex phenomenon that has unique ties to PTSD, particularly in the context of chronic pain.<sup>70</sup> Acute pain 24 hours post-surgery has also been identified as a predictor of clinically significant self-reported PTSD symptoms following lung cancer surgery at three-month follow-up.<sup>11</sup> This relationship may be explained by sensitivity to pain traumatization, a higher order construct characterized by a tendency to display anxiety and trauma-related responses to pain (e.g., pain catastrophizing, anxiety sensitivity), where pain is a traumatic stressor.<sup>71</sup> Pain has been conceptualized recently as a potentially distinct feature of illness-induced PTSD compared with traditional PTSD conceptualizations, where the experience of pain in the context of illness is a component of the traumatic event (criterion A) eliciting PTSD. The experience of chronic pain may act as a somatic internal trigger that results in intrusions and continued arousal related to the medical event or surgery.<sup>21</sup> The use of morphine in traumatic injury contexts has been found to reduce post-event PTSD symptoms.<sup>72,73</sup> Thus, the presence of acute pain may not only be a risk factor for PTSD, but appropriate analgesia might also reduce the likelihood of postoperative traumatic stress.

### Assessment

Given that postoperative traumatic stress is reported by approximately 20% of patients undergoing major surgery, consideration must be given to screening and early treatment. There are well-validated trauma assessment

screening tools, like the Clinician-Administered PTSD Scale,<sup>74</sup> that involve face-to-face interviews with trained professionals. These gold standard assessments may not be feasible for routine screening by perioperative clinicians. Unfortunately no specific perioperative screening tools have been developed. We believe understanding symptom presentation of postoperative PTSD is essential to develop appropriate assessment tools.

The PTSD Checklist (for the DSM-5; PCL-5) is widely accepted as a valid self-reported measure of PTSD symptoms. Either a cutoff score based on an aggregate sum or a calculation based on endorsing specific symptoms can be used, which align with criteria in the DSM. Research suggests that the 20-item PCL-5 is a valid and reliable assessment of DSM-5 PTSD<sup>75-77</sup>; however, this has yet to be investigated in surgical contexts. It is a practical tool because of its self-report nature and that a continuum of severity can be established, which may better reflect the spectrum of postoperative traumatic stress. The Primary Care PTSD Screen for DSM-5 may also be advantageous. This represents a shorter scale and is appropriate for medical populations.<sup>78</sup> Other self-report PTSD measures that have been validated in ICU settings may also be useful such as the Impact of Events Scale-Revised and the Post-Traumatic Stress Syndrome ten question inventory.<sup>79,80</sup> Identification of individuals with sub-threshold symptoms in the early postoperative period using distress measures may also be appropriate. The Peritraumatic Distress Inventory<sup>81</sup> and the Acute Stress Disorder Scale<sup>82</sup> may be particularly efficient screening tools to implement in the short-term postoperative timeframe. These have been found to be predictive of PTSD<sup>82</sup> (see Table for a summary of scales).

To understand post-traumatic stress symptoms directly linked to the perioperative period, it is important to have patients temporally respond to symptom questions *since* their surgery to understand postoperative traumatic stress as opposed to lifetime experiences. In some cases, this might require minor modifications of directions on self-report measures.

Assuming one selects an appropriate screening tool, it remains unclear *when* a clinician should assess for postoperative traumatic stress. A diagnosis of PTSD would not be given prior to one month following the index trauma. The DSM-5 diagnostic nomenclature for acute stress disorder suggests it can be assessed as early as three days following the index traumatic event. Some argue this is premature and may not be an accurate reflection of one's stress response, particularly during hospitalization when an individual may experience dysregulated sleep and are removed from their social and physical environment.<sup>83</sup> Given the dearth of research, there is no consensus regarding appropriate timing for assessing postoperative traumatic stress. We suggest an evaluation of risk factors at discharge (e.g., dissociation, delirium, acute stress) with a one-month follow-up of postoperative traumatic stress symptoms in those at risk.

## Interventions

The nature of surgery and postoperative care provides a unique opportunity for early case identification and intervention. Early pharmacological and psychological interventions targeted at acute stress were associated with a reduced risk of progression to PTSD.<sup>7,84-86</sup> Psychotherapy following an ICU stay was found to reduce reports of PTSD symptoms at 12-month follow-up.<sup>87</sup> The use of hydrocortisone has also been found to reduce PTSD symptoms and chronic stress in both surgical<sup>88-90</sup> and non-surgical mixed trauma<sup>91</sup> populations. This represents an exciting area of inquiry for postoperative traumatic stress. Preoperative educational, exercise, and psychological prehabilitation programs have improved mental and physical functioning before and after surgery. For example, these programs are associated with increases in preoperative mobility and quality of life, and reductions in preoperative depression, postoperative pain, catastrophizing, and disability.<sup>92-96</sup> A growing body of research investigating the utility of ICU diaries (a written daily account of procedures and the patient's progress) may assist the patient in creating a consolidated narrative thereby reducing rates of post-traumatic stress.<sup>7,97-99</sup> The use of a structured mirrors intervention, involving visual feedback of one's immediate environment, has also been shown to improve factual memory recall following surgery and may have implications for PTSD.<sup>100</sup> Finally, recent advancements in PTSD literature suggest that early intervention (i.e., approximately 12 hours post-trauma) of a modified prolonged exposure treatment following traumatic injury may reduce the risk of post-traumatic stress reactions in

emergency room contexts.<sup>101</sup> The integration of such interventions in surgical contexts requires further study.

## Conclusion

Extant literature suggests that postoperative traumatic stress may occur in approximately 20% of patients, with particular surgical populations being at even greater risk. These findings should raise concern given the number of annual surgeries and the documented negative health implications of PTSD among surgical patients.<sup>10</sup> It is possible that several triggers exist (e.g., the illness leading to the surgery, intraoperative awareness, delirium) and symptom presentation and duration may vary. The most compelling evidence to date comes from studies on intraoperative awareness. The experience of intraoperative awareness with its threat of death or serious injury aligns with traditional discrete event-triggering conceptualizations of PTSD. It remains unclear whether postoperative PTSD is more closely aligned with the traditional conceptualization of PTSD as outlined in the DSM or the newly proposed illness-induced PTSD<sup>26</sup>; the symptom presentation may depend on the traumatic component (i.e., the trigger) of the perioperative experience. Current assessment tools may not adequately capture the essence of this presentation and additional research is required to understand the utility of these assessment instruments in surgical populations.

Health professionals have a unique opportunity to better understand risk factors of postoperative traumatic stress as the traumatic index event (surgery) is predictable. This makes it possible to conduct prospective controlled research to understand, assess, and treat postoperative traumatic stress and PTSD.

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