

# Pediatric Anesthesia, Psychology, and Interventions: A Narrative Review

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**Abstract:** The maintenance of pediatric perianesthetic mental health is more specific compared with that in adults, involving anesthesiology, pharmacology, psychology, nursing, pediatrics, and other disciplines. Although anesthesia can effectively prevent children from recalling the events of the surgical procedure, about 65–80% of children suffer from great anxiety and discomfort during surgical preparation, especially during anesthesia induction. The most obvious consequence of anxiety during anesthesia induction is that children are prone to extreme discomfort and mania during induction, and postoperative behavioral disorders are prone to occur after awakening, which is manifested as anxiety about separation from parents, anger, fear of strangers, loss of appetite, nightmares, nocturia, and other adverse symptoms. Most of these symptoms will go away on their own, but some may persist for a long time and have adverse psychological and physical effects in the future. Caring for the psychology of pediatric anesthesia induction can not only make anesthesia induction smoother but also reduce the incidence of delirium in children during awakening, reduce psychological trauma, and shorten the postoperative monitoring time. It is an important task for anesthesiologists to optimize the preoperative preparation of children, improve the induction method of anesthesia, and maintain pediatric mental health.

**Keywords:** anesthesia, pediatric, psychology, anxiety, fear, intervention

## Introduction

Perioperative psychological issues in children have always been a focus of attention for clinical doctors and anesthesiologists, with the incidence high to 65~80%.<sup>1,2</sup> Preoperative children may experience psychological problems for a variety of reasons, including fear of dying, fear of emergence from anesthesia, fear of the unknown, anxiety of losing control, pain, loneliness, and separation from parents.<sup>3</sup> These psychological problems have been seen in pediatric patients in a variety of manifestations, such as feeling scared, anxious, breathing heavily, shaking, sobbing, ceasing to talk, or ceasing to play. Some young kids might urinate unexpectedly, or try to escape from the medical staff.<sup>4–9</sup>

The induction of anesthesia appears to have been the most distressful experience for pediatric patients during the preoperative period.<sup>10</sup> The pediatric patient refused anesthesia induction at the last moment due to psychological issues, which posed a challenge to anesthesiologists and surgeons, and also put pressure on the children and parents.<sup>11</sup> This common issue can negatively affect children's psychological and physical health and result in unfavorable consequences like a higher need for anesthetics, maladaptive postoperative behaviors, including eating problems, nightmares, separation anxiety, and poor recovery.<sup>12,13</sup> Therefore, how to maintain the psychological health of patients during the perioperative period and enable them to pass the anesthesia induction period peacefully and smoothly is a key issue that anesthesiologists urgently need to solve.

Premedication and parental presence during the induction of anesthesia (PPIA) are common strategies for managing anxiety in children during the perioperative period. These techniques have drawbacks and restrictions of their own, such as the difficulty of giving medicine to anxious children and the minimal effectiveness of PPIA in alleviating preoperative anxiety.<sup>13</sup> Numerous investigations have examined audiovisual distraction as innovative approaches and exhibited their efficacy in reducing perioperative anxiety in children.<sup>14–17</sup> In addition, adequate psychological preparation should be

provided to the child before anesthesia induction, so that the child can adapt to the anesthesia induction environment in advance and effectively reduce the incidence of psychological problems during anesthesia induction.<sup>18</sup>

The paper mainly includes three aspects: perioperative psychology in children, anesthetic induction on pediatric psychology, and perioperative interventions. It is our aim that by using suitable anesthetic introduction methods and executing interventions that include both pharmaceutical and non-pharmacological techniques, anesthesiologists will experience significant benefits.

## Perioperative Psychology in Children

Because children are too young to have a comprehensive understanding of the disease, their psychological state is easily affected by the external environment.<sup>19</sup> Surgical procedures can have a negative psychological impact on children,<sup>20</sup> and anesthesia-induced perioperative period is also a potential factor for adverse emotions. There are great differences in the psychological response of children of different ages to anesthesia and surgical procedures, especially when they are separated from their families before surgery, they will show obvious fear, crying, restlessness, and screaming.

### Anxiety

The psychological development of children is not yet mature, and the anxiety caused by anesthesia during the perioperative period is usually due to separation from family members and fear of an unfamiliar environment.<sup>21</sup> According to Parris et al,<sup>22</sup> anxiety is a typical emotional response to undergoing any kind of surgery and happens in reaction to events that pose a physical threat. School-age children are more concerned about their own conditions, treatment and other problems, and emotions such as anxiety and anger are more common. The study conducted by Chow et al<sup>23</sup> showed that the frontal brain activity plays a regulating role between shyness and preoperative anxiety in children. Perioperative anxiety in children is associated with a variety of postoperative adverse complications, such as pain,<sup>24</sup> behavioral disturbance<sup>25</sup> and emergence delirium.<sup>26</sup>

Many instruments can be used to measure a child's level of preoperative anxiety. The Amsterdam Preoperative Anxiety and Information Scale (APAIS) is a simple and reliable questionnaire that can be completed in a few minutes.<sup>27</sup> APAIS is suitable for the evaluation of preoperative anxiety and fear of anesthesia in children.<sup>28</sup> Anesthetists use APAIS to improve patient care by assessing patients and the degree of information they require to reduce their anxiety.

### Fear

Fear is a common perioperative emotion in children, and the main manifestations are crying, struggling, and refusal of examination and operation. The specific causes of fear in children are separation from parents, fear of surgical procedures, changes in the environment, behavioral constraints, and fear of physical exposure.<sup>29</sup> Psychological fear and physical trauma directly affect the normal psychological activities of the child, so that the resistance of body is reduced. Severe psychological reactions can lead to autonomic dysfunction, which is not conducive to anesthesia induction and management. Improper psychological preparation or the use of coercive measures in children before anesthesia may cause mental trauma in children.<sup>30</sup> Children's fear can be precisely measured by special scales, and Children's Fear Scale might be a good choice.<sup>31</sup>

### Pessimism

Pessimism and depression are more common in introverted children, who are unwilling to communicate with others, and have a more one-sided understanding of the disease, which is mostly manifested as being silent, independent behavior, loss of interest in the things around them, and even suicidal tendencies in severe cases.<sup>32</sup>

## Anesthesia Induction on Pediatric Psychology

### Inhalation Anesthesia

Inhalation induction of volatile anesthetics is the most important induction method for pediatric anesthesia in the world. Among them, sevoflurane, desflurane, and halothane are the most used in induction. Compared with halothane,

sevoflurane has a faster induction speed, less circulatory adverse reactions, a low incidence of adverse reactions such as cough and laryngospasm during induction, and a fragrant smell and a relatively appropriate price, which is the first choice for pediatric induction anesthesia.<sup>33</sup> The blood gas partition coefficient of desflurane is lower, and the induction and recovery of the child are more rapid. However, inhalation anesthetics may cause excitatory agitation in children during induction and emergence, and may induce epilepsy, which should be brought to the attention of the anesthesiologist.<sup>34</sup>

Mahajan et al<sup>35</sup> installs a whistle device at the end of the open sac to encourage the child to breathe through the mouth and inflate the sac to elicit the sound of the whistle. During this procedure, the anesthesiologist turns on sevoflurane and N<sub>2</sub>O to allow the child to fall asleep during the game. This approach avoids the “mask fear” of the child and reduces discomfort with the odor of sevoflurane. Clinical studies have shown that this new device, with the cooperation of parents, can make it easier for children to complete anesthesia induction more quickly.

## Intravenous Anesthesia

Intravenous anesthesia is the second most used method of induction of pediatric anesthesia after inhalation. Commonly used intravenous anesthetics include propofol, etomidate, ketamine, etc. Generally speaking, compared with inhalation anesthesia, intravenous anesthesia imposes a greater impact on children’s psychology and will cause children to have more severe anxiety.<sup>36,37</sup> This is because inhalation anesthesia is relatively painless, and at the same time avoids the psychological trauma caused by the “needle fear” in children.<sup>38</sup> However, there are also studies that offer contradictory views. Bal et al<sup>39</sup> compared the subhypnotic dosage of propofol with sevoflurane induction in children to investigate the impact of propofol and sevoflurane on perioperative anxiety and postoperative behavioral disturbances (PBD) in children. They found that the incidence of anxiety and PBD was not decreased by adding subhypnotic propofol to sevoflurane induction. In addition, when compared to sevoflurane and sevoflurane with propofol groups, the propofol induction group exhibited a much lower fear of darkness and nightmares, as well as a greater desire to sleep with parents. Gazal et al<sup>40</sup> investigated the effect of inhalation and intravenous inductions on preoperative anxiety and distress in 212 children undergoing tooth extraction, and found that compared to patients who underwent an intravenous induction, those who had an inhalation induction showed greater anxiety and distress. But the author did not give a reasonable explanation for the cause of this phenomenon. This may be because children with dental disease have a more sensitive face due to pain and therefore show greater anxiety and resistance when using face masks.

## Intramuscular Injection or Intravenous Injection

Although anesthesia induction methods such as intramuscular injection or intravenous injection have a rapid onset of effect, injection is easy to bring adverse psychological effects to awake children. Piotrowski<sup>41</sup> mentioned that among the eligibility criteria for pediatric anesthesia for elective surgery, invasive procedures such as injection and intravenous catheterization must be avoided in sensitive children. For children who are generally well, the clinical examination and evaluation of the physician is more valuable than various invasive tests (such as blood tests), and all kinds of invasive procedures and examinations should be avoided in conscious children as much as possible. Pediatric questionnaires showed that the most worrying factor in the perioperative period was pain during injection.<sup>42</sup> These suggest that intramuscular or intravenous injection should be discarded in pediatric anesthesia induction.

## Intranasal Administration

Intranasal administration can avoid the pain caused by intramuscular and intravenous injections, but it is less acceptable than oral administration. Bayrak et al<sup>43</sup> compared nasal sufentanil with oral midazolam and tramadol, and concluded that nasal sufentanil and oral midazolam were more suitable for pediatric anesthesia induction than oral tramadol. Gautam et al<sup>44</sup> suggested that nasal midazolam had a slightly slower interim onset of action than nasal ketamine. Intranasal dexmedetomidine premedication is a newly introduced method for reducing stress and anxiety before general anesthesia in children. A systematic review concluded that intranasal dexmedetomidine provided more satisfactory sedation at parent separation and reduced the need for rescue analgesics and the incidence of nasal irritation and postoperative nausea and vomiting when compared with other premedication treatments.<sup>45</sup>

In summary, anesthesiologists should weigh the pros and cons, fully consider the impact of induction methods on the psychological, circulatory, respiratory, and other aspects of the pediatric patient, and after a comprehensive evaluation of the patient's preoperative psychological state and general situation, choose the most suitable anesthesia induction method.

## Perioperative Interventions

### Psychological Preparation

The child is in the stage of growth and development, with all organs, systems, psychology, and mental activities in the developmental stage. Children are more sensitive to unfamiliar environments and groups of strangers, and know little about their own diseases and treatment plans, which leads to a decrease in their cooperation with surgical procedures and an increase in their fear. Therefore, it is necessary to provide psychological counseling before surgery.<sup>46</sup>

Meletti DP et al conducted systematic psychological preparation before the surgery, including having a semi-open interview with parents and children, and telling a story regarding the experience of surgery and anesthesia, and found that this approach could significantly relieve preoperative anxiety in children.<sup>18</sup> A recent clinical randomized trial demonstrated that employing a dialogue-based patient-centered communication with the children preoperatively can significantly improve their psychological anxiety, reduce the usage of anesthetics, and increase the compliance of anesthesia introduction.<sup>47</sup>

Therefore, anesthesiologists should evaluate the psychological condition of the children before surgery, help them prepare adequately, and avoid psychological trauma caused by anxiety and fear during anesthesia induction.

### Traditional Distraction

Distraction is frequently employed as a nonpharmacologic technique by medical practitioners and parents to lessen the pain and anxiety associated with procedures for pediatric patients.<sup>48</sup> There were many different types of distraction interventions, which may be divided into active and passive categories. Playing games,<sup>49</sup> painting, or playing with toys are examples of active types of distraction that pediatric patients can engage in under adult supervision. On the other hand, passive sources of distraction include things like viewing a video or listening to music.<sup>50</sup>

Numerous experiments have been carried out to assess how distraction affects anxiety before surgery. Forouzandeh et al found that interactive games and painting are effective in alleviating preoperative anxiety in children undergoing elective surgery.<sup>51</sup> A 2022 meta-analysis included 2525 children from 26 studies and found that game-based intervention such as cartoon, painting and tablet computer game, considerably reduced the severity of preoperative anxiety in children (MD -10.62, 95% CI -13.85 to -7.39).<sup>52</sup> Another 2022 meta-analysis of 1341 children in nineteen studies demonstrated that preoperative distraction interventions considerably refined the severity of anxiety in pediatric patients in holding area (MD -5.34, 95% CI -7.97 to -2.71) and induction room (MD -15.28, 95% CI -21.48 to -9.09), and the subgroup analysis showed that both active forms and passive forms of distraction are effective.<sup>53</sup>

Some studies have also yielded negative conclusions. A randomized controlled trial conducted by Huntington et al found that family-centered interactive on-line games did not lessen the preoperative anxiety in children undergoing dental extractions.<sup>54</sup> However, current research has some limitations. Some confounding factors, such as patient baseline characteristics (gender, age, personality traits), preoperative pain, parental anxiety levels, etc., can also affect the preoperative anxiety level of patients, but few studies have conducted stratified analysis on them.<sup>53</sup> As the current literature indicates a variety of distraction intervention techniques, and most of these findings come from single center, more studies with superior study designs and larger scale samples are necessary before conclusions can be made.

### VR Distraction

Virtual reality (VR) is a novel technology that employing a headset to display a completely immersive three-dimensional environment,<sup>55</sup> and Children's anxiety and discomfort have been demonstrated to relieve when they are distracted with VR. A 2022 meta-analysis of seven studies found that virtual reality offers a potential distraction strategy for pediatric children undergoing elective surgery, which may help lower anxiety levels.<sup>56</sup> A randomized controlled study showed that

children who received a preoperative VR headset that displayed a game had significantly lower preoperative pediatric anxiety score.<sup>57</sup> In addition, VR can be applied as a tool for exposure, but the effect of VR as an exposure tool on preoperative anxiety still need further studied.<sup>58</sup>

However, another randomized clinical trial found that exposing to the virtual reality environment from the holding area until the completion of induction did not alleviate the preoperative anxiety in children, but can reduce the incidence of postoperative rescue analgesia.<sup>59</sup> The lack of evidence of a relationship between VR and anxiolysis in this study may have resulted from the limited investigation of relatively mild procedures, the timing of the VR intervention and surgery, and the comparatively low anxiety levels before introduction of anesthesia.

## Parental Presence

PPIA refers to parental companionship and comfort during the anesthesia induction phase to alleviate the anxiety and distress of children and increase the smoothness of induction,<sup>60</sup> which has been proven effective on preoperative anxiety in recent studies.<sup>61,62</sup> A randomized clinical trial by Sadeghi et al showed that PPIA may lessen preoperative anxiety in pediatric patients measured by Induction Compliance Checklist (ICC) scores and enhance the quality of anesthesia induction, but it has no effect on parental anxiety.<sup>63</sup> Wright et al pointed out that the presence of parents can significantly reduce children's anxiety when entering the operating room, but for other time points such as preoperative visits, anesthesia mask induction, recovery room, and the first day after surgery, the presence of parents has no significant effect on reducing children's anxiety.<sup>64</sup> However, there has been academic debate on whether parental presence is beneficial for reducing preoperative anxiety in pediatric patients. A Cochrane systematic review analyzed eight studies and found that the presence of parents only alleviate parental anxiety and but not reduce the anxiety of children.<sup>65</sup> The reason may be that different studies used different scales to measure anxiety levels, which makes it difficult to summarize and analyze the scores of the scales.

In addition, studies have also observed the effect of PPIA combined with medication intervention on preoperative anxiety in pediatric patients.<sup>66</sup> A randomized trial found that PPIA in conjunction with midazolam is a very successful tactic for lowering preoperative anxiety, ensuring complete compliance with anesthetic induction, and attaining decreased incidence and intensity of emergence delirium, especially in children less than five years old.<sup>67</sup> Future research can focus on the impact of PPIA on more outcome indicators, such as intraoperative conditions and postoperative recovery, in order to form more definitive and comprehensive conclusions.

## Premedication

### Midazolam

Midazolam is a short-acting phenylpiperidine drug with sedative, anti-anxiety, and amnesic effects, and is often used as a preoperative medication. It has been proven that midazolam can alleviate preoperative anxiety in children, but it will not delay their recovery and discharge. Several controlled study compared midazolam to parent presence, and found that midazolam has a better effect on alleviating preoperative anxiety and increasing compliance in children than in the presence of parents during anesthesia induction.<sup>68,69</sup>

However, some scholars have shown that midazolam can increase postoperative anxiety in children, and the explanation for this is the impact of midazolam on external memory.<sup>70</sup> Because the child is not yet aware of the fact that the surgery has ended, if the child believes that they have experienced anesthesia induction but have no memory of it, the subsequent surgery will be considered a new and unsettling experience.

### Dexmedetomidine

Dexmedetomidine is a highly selective  $\alpha_2$  adrenergic receptor agonist that acts on the locus coeruleus receptors in the brain to produce sedation and anti-anxiety, and on spinal cord receptors to produce analgesia. Dexmedetomidine does not exhibit significant respiratory depression while combating the stress response of body. Both nasal and oral administration of dexmedetomidine is acceptable for pediatric patients. A 2023 meta-analysis demonstrated that compared to midazolam, applying of dexmedetomidine showed a higher rate of satisfactory anesthesia induction and facemask acceptance.<sup>71</sup>

Physiological sleep is induced after sedation, and the child can quickly awaken. When separated from parents and induced under anesthesia, the child can exhibit more sedative behavior, facilitate communication and cooperation, and improve parental satisfaction. Therefore, dexmedetomidine has more advantages than traditional medication, and its application scope as a preoperative medication is gradually expanding.<sup>72</sup>

### Clonidine

Premedication with clonidine is becoming more common since it is an alpha 2-adrenergic agonist with analgesic qualities in addition to sedative ones. It has been demonstrated that when administered orally or through the nose as a premedicant, it has anxiolytic properties, lowers the need for volatile anesthetics, and improves postoperative analgesia and perioperative hemodynamic stability.<sup>73,74</sup>

According to research by Almenrader et al, oral clonidine is preferable to oral midazolam because it is easier for children to take in, works better for premedication, calms children down when they wake up, and is more well-liked by parents.<sup>73</sup> A randomized controlled trial showed that intranasal clonidine performed better on mask acceptance, drug acceptance than intranasal midazolam, but the effect of anxiolysis in two groups are comparable.<sup>75</sup>

### Hypnosis

Clinical hypnosis has emerged as a potentially beneficial treatment for children's procedural pain and distress due to evidence of effectiveness and potential superiority to other psychological interventions.<sup>76</sup> Hypnosis involves controlled modulation of components of cognition-such as awareness, volition, perception and belief-by an external agent or by oneself employing suggestion.<sup>77</sup> One group showed the potential of hypnosis as both an adjunct and, in suitable cases, alternative to traditional pharmacological anesthesia.<sup>78</sup>

### Conclusion

For children, the preoperative phase can be quite stressful and distressful. Maladaptive psychology during this time is linked to the child's clinical recovery and postoperative behavior. Inappropriate anesthesia induction methods may increase children's fear and anxiety during induction. Comprehensive assessment of individual child's fear or anxiety using specific scales are highly recommended. For sensitive children, invasive anesthetic induction methods should be avoided. There are numerous ways to help children feel less anxious before surgery. Well-established distraction measures may help a lot and should be taken. The combination of different interventions (eg, parental presence and medication intervention) might be a valuable try. To assist parents and children in managing the stress that comes with perioperative period, it is critical to comprehend psychological issues associated with surgery and anesthesia.

### Funding

This study was funded by Health commission of Weifang, China (Grand number WFWSJK-2021-068).

### Disclosure

The authors report no conflicts of interest in this work.

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