Postanesthesia Care Unit Risks Following Pediatric Neurosurgery

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Overview

In this chapter, we will review the issues that are of importance in the initial postoperative recovery of the pediatric neurosurgical patient. The pediatric anesthesiologist is able to control many factors that influence cerebral blood flow (CBF), cerebral metabolic rate for oxygen ($CMRO_2$), and intracranial pressure (ICP). When there are immediate postsurgical concerns, failure to awaken, or new neurological signs, the actions of the anesthesiologist may be instrumental in determining the outcome. The advantages and disadvantages of obtaining a CT or MRI scan prior to emergence from anesthesia versus a delayed or "as-needed" scan will be discussed. The goal of the pediatric neuroanesthesiologist is to provide stability of hemodynamics, respiratory parameters, and temperature control and of metabolic and endocrine factors. This stability must continue into the postoperative period to ensure an optimal neurological outcome.

Implications for the Neurosurgical Patient

Blood Pressure Control

A normal newborn autoregulates intracerebral blood flow at mean blood pressures between 20 and 60 mmHg, with a steep rise and fall at either end of the autoregulatory curve. The brain of an infant or child receives a relatively larger percentage of the cardiac output as compared to adults. After traumatic brain injury, young age (less than 4 years) has been shown to be an independent risk factor for impaired cerebral autoregulation. These factors place pediatric neurosurgical patients at particular risk for ischemia at low blood pressures and for hemorrhage at high blood pressures. Short-acting vasoactive agents such as intravenous esmolol or labetalol may be needed in PACU for acute control of hypertension, and adequate fluid and blood replacement must be given to avoid hypotension.

Pain Management

Adequate analgesia is essential, so that the hyperventilation that may occur with crying can be avoided. A balance of adequate analgesia without oversedation (which may mask a change in neurological status) can be challenging. Short-acting intravenous opioids such as fentanyl or remifentanil are commonly used, but there is then a need to titrate longer-acting intravenous agent during emergence. If remifentanil has been used, there is the possibility of acute tolerance with an unexpectedly high opioid requirement in PACU, although studies have not universally confirmed this finding. An age-appropriate pain scale must be used accurately to determine the level of pain, so that it may be adequately controlled. Some scales to consider include the modified infant pain scale (MIPS), the FLACC behavioral scale, the Wong–Baker FACES pain rating scale, and the Oucher. Older children may be asked to report using the familiar 0–10 visual analogue scale (VAS). If opioids are needed, a patient-controlled analgesia (PCA) system may be a good option for delivery, so that the older child can titrate to an adequate level of analgesia but can also avoid sedation that may occur if opioids are given by continuous infusion or by nurse-administered bolus doses. Excessive treatment of pain may result in sedation of the patient, making neurological assessment difficult. In addition, there may be respiratory depression leading to elevated arterial levels of carbon dioxide (CO_2) which may in turn cause somnolence. Patients who have had surgery close to the brain stem, such as a Chiari decompression, may be especially sensitive to even a mildly elevated level of CO_2. Hence there is a need to balance treatment of pain versus the risk of somnolence and impaired neurological assessment. Administration of intravenous naloxone to relieve narcotic-induced somnolence or respiratory depression can cause significant hypertension, so opioids must be titrated with care to avoid the need for reversal of their effects.

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COX-2 inhibitors do not have antiplatelet properties compared to NSAIDs and can reduce opioid requirements without increasing bleeding risks. Adult studies have demonstrated a 6–12 h post-op pain reduction in patients undergoing craniotomy who received a single dose of parecoxib but no significant effect on overall analgesia post-op. There are concerns of possible cardiovascular effects due to thrombotic events. Therefore, COX-2 use in the pediatric population is still unknown – the decision to use it needs to be discussed with the surgical team to weigh the risk benefits.

Temperature Management

Shivering significantly raises oxygen consumption and metabolism, and so efforts should be made to maintain normothermia and to treat shivering promptly with warming blankets or pharmacological treatments such as ketamine or low-dose meperidine if it occurs. Hyperthermia may occur with either an infectious or noninfectious etiology and should be treated, no matter what the cause. Combination therapy (acetaminophen, ibuprofen, and physical cooling) may be needed effectively to maintain normothermia.

Postoperative Nausea and Vomiting

Postoperative nausea and vomiting (PONV) should be treated to avoid the potentially deleterious effects of a Valsalva maneuver during vomiting which may transiently raise ICP or increase the risk for intracranial hemorrhage. A combination of 5-HT3 inhibitors along with dexamethasone is commonly used. Dexamethasone has additional anti-inflammatory effects via modulation of peripheral nociceptors and reduces vasogenic edema. It also reduces pain when used in combination with other analgesics in a multimodal approach.

Endocrine Issues

A few patients who have had surgery in or close to the pituitary fossa will need close monitoring for early signs of the development of diabetes insipidus, manifested by abnormally high volumes of dilute urine and plasma hypernatremia. Judicious fluid therapy is essential – these patients often need hypertonic fluids and frequent monitoring of electrolytes. Other endocrine derangements such as hyperglycemia or hypoglycemia are also possible. One study demonstrated a poor outcome following brain injuries in children when blood glucose levels were elevated (above 250 mg/100 ml).

Respiratory Management

Neurogenic pulmonary edema (NPE) is a complication unique to neurosurgical patients who have had intracranial surgery or injury. It can be life-threatening, and the exact etiology and pathophysiology are incompletely understood. The neuroanesthesiologist must be ready to provide respiratory support, including reintubation and ventilation, if this complication develops in order to maintain oxygenation and normocarbia.

Concerns and Risks

Elevated ICP

Neurosurgical patients experience cerebral hyperemia during emergence from general anesthesia, independent of the anesthesia technique used. Delay of extubation does not attenuate the increase in heart rate, mean arterial pressure and oxygen consumption, and catecholamine surge that occur at extubation. For patients whose raised ICP has not been alleviated by surgery, who had surgery of long duration, had major blood loss, or may have cranial nerve damage that impairs airway protective reflexes, controlled ventilation with adequate sedation may be necessary after surgery. When the time comes to extubate such patients, one should remember that raised ICP has an association with delayed gastric emptying, so suction must be available, and the patient should be fully awake and optimally positioned to reduce the possibility of aspiration.

Seizures

Seizures significantly raise the cerebral metabolic rate for oxygen. Early postoperative seizures are defined as those occurring within the first week after surgery. They occur in 15–20% of patients who have had a supratentorial tumor resection. Close monitoring for postoperative seizures is necessary. Prophylaxis for seizures is generally left to the neurosurgeon's preference as prospective trials are lacking. Phenytoin is commonly given in the perioperative period. A seizure postoperatively must be treated promptly with basic airway and respiratory support, with concurrent communication with the neurosurgical team.

Postoperative Neuroimaging

Timing of postoperative CT or MRI scans is controversial. This practice is not universal; some institutions scan on an as-needed basis only (change in neurological status or seizures being indications to scan), while other institutions scan routinely on postoperative day 1. There is a strong argument for rapid awakening of these patients to allow early neurological assessment and early diagnosis of adverse postoperative neurological outcomes. The anesthesiologist in PACU must be able to respond in a timely manner to adverse hemodynamic and respiratory events. Delayed response to these hemodynamic and respiratory changes can theoretically result in cerebral ischemia, raised ICP, altered consciousness level, and long-term adverse outcomes.

Failure to Awaken

The following goals are desirable clinical targets in the pediatric neurosurgical patient. One or more of these factors may need to be corrected for the patient who fails to awaken at the end of surgery (Table 67.1).

Table 67.1 Failure to awaken

Metabolic:
Temperature – >36°, avoid hyperthermia
Blood glucose – >60 mg/100 ml and <200 mg/100 ml
Osmolality – >275 mOsm/kg, <300 mOsm/kg
Respiratory:
Spontaneous ventilation – CO2 <50 mmHg, Sp02% >94%
Circulation:
Euvolemia, normal BP
Coagulation and hematocrit within normal limits
Neurological:
Intact cranial nerves
Near normal or baseline neurological state
No significant brain edema
No further seizure activity
Pharmacology:
Adequate reversal of muscle relaxants

If all of the above parameters have been considered and corrected if necessary, emergent imaging and neurosurgical consultation may be needed to rule out postoperative hemorrhage or edema for any patient who fails to awaken.

New Neurological Signs

A concerning development in PACU is the occurrence of new neurological signs and symptoms. These must be assessed promptly by both neurosurgeon and anesthesiologist (Fig. 67.1).

Key Points

- The major concern when caring for a pediatric neurosurgical patient in the PACU is finding the balance between adequate analgesia while providing an alert, interactive patient for confirmation that no new neurological deficits have occurred.
- The effect of any intervention (or lack of intervention) on ICP, the threshold for seizure activity, or altering level of consciousness must always be

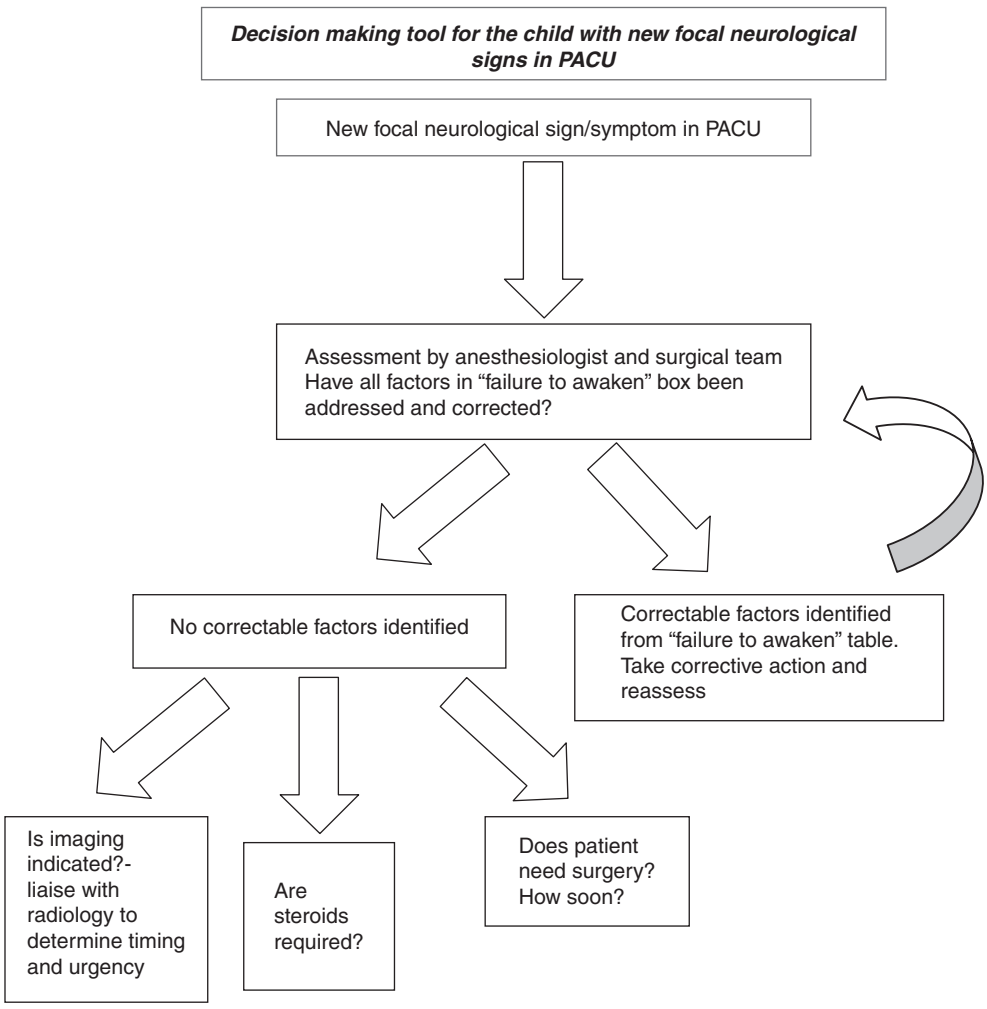

Fig. 67.1 Decision-making tool for the child with new focal neurological signs in PACU

considered as etiologies for postoperative neurologic dysfunction.

- Meticulous attention to pain control, control of PONV, careful management of fluid status to achieve euvolemia, and maintenance of normothermia, normal osmolality, and normoglycemia are essential.
- In pediatric neurosurgical patients, it is particularly important to avoid hypoxemia, hypercarbia, and hyper-/hypotension, since derangements in arterial blood gases or in blood pressure can have profound effects on the cerebral vasculature, resulting in intracranial hemorrhage, raised ICP, or vasospasm, causing new neurological deficits.

Suggested Reading

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