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ANESTHETIC MANAGEMENT FOR SURGERY OF CHILDREN WITH BRAIN TUMORS: SYSTEMATIC REVIEW

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Aim. Based on publications dedicated to anesthetic management for surgery of children with brain neoplasms we aimed to reveal and summarize the specific features of anesthesia of such patients. **Materials and Methods.** We performed a systematic review and processed the information from Russian and foreign literature published in 2001–2016. The analysis included patients younger than 18 who had undergone surgical procedures due to brain tumor. **Results.** The conducted analysis allowed us to classify surgical interventions into three main categories (shunt surgery, open surgery, neuroendoscopy) and to determine category-specific features of anesthetic management. The analysis results also made it possible to describe the algorithms of preoperative preparation, recovery stage, and early postoperative period for anesthesiologist. **Conclusion.** The review has shown that brain tumor surgery is one of the most complicated operations requiring a well-coordinated teamwork. Anesthesiologist has not only to be especially well-trained and skilled, but to cooperate closely with neurosurgeon, which may be even more critical. Psychological, ethical, and professional aspects of such cooperation are a subject of further detailed research.

Keywords: *anesthetic support, pediatric anesthesiology, emergence, preoperative assessment and preparation, surgery, children, brain neoplasm.*

Introduction

Brain neoplasms in children represent 15 % to 20 % of all tumors in pediatric oncology being the most frequent pathology after leucosis (25–30 %) [1]. Medulloblastomas are the most common type of pediatric brain tumors. Their symptoms are mainly due to increased intracranial pressure [2].

Even benign brain tumors in children tend to be rapidly growing, to adhere to the adjacent structures, to compress tissues, and to disturb or even stop the blood supply of cerebral regions. This causes transient or persistent malfunctions of affected cerebral structures (the brain stem, tentorium, ventricles, or optic chiasm):

- motor disturbances;
- sensitivity defects;
- disturbed coordination;
- hearing or vision impairments;
- malfunctioning of some body systems (respiratory, cardiovascular) or ingestion;
- mental disorders.

Brain tumor surgery is the only radical treatment. For that reason it is necessary to consider all nuances of anesthetic management for these operations, which requires understanding the anatomic and physiological differences between the child's and adult's bodies, individual traits of each patient, and the expected volume of surgical intervention [3].

Materials and Methods

We performed a systematic review and processed the information from Russian and foreign literature published in 2001–2016. The analysis included patients younger than 18 who had undergone surgical procedures due to brain tumor.

Anatomic and physiological features of the child's body

As the child's body is still developing after birth there are several anatomic and physiological features to be considered by anesthesiologist while planning and implementing anesthetic management. Most often, only special equipment and methods of anesthesia are appropriate for surgery in children [4].

Physiological features

- Cardiac output to a large extent depends on heart rate (HR).
- HR is higher than in adults.
- Blood pressure (BP) is lower than in adults.
- Respiration rate is higher than in adults.
- Lung compliance is lower than in adults.
- Thoracic compliance is higher than in adults.
- Functional residual capacity (FRC) is lower than in adults.

• Body surface area / body weight ratio is higher than in adults.

• Total water level is higher than in adults.

Anatomic features

• Very low left ventricular compliance.

• Residual fetal circulation (in neonates).

• Difficult arterial and venous catheterization.

• Large head and tongue.

• Narrow nasal passages.

• More cranial and ventral position of the larynx.

• Long epiglottic cartilage.

• Short trachea and neck.

• Protruding adenoids and tonsils.

• Weak diaphragm and intercostal muscles.

• High airway resistance.

Pharmacologic features

• Immature mechanisms of hepatic biotransformation.

• Low binding capacity of proteins.

• Fast induction of anesthesia and emergence.

• Increased minimum alveolar concentration (MAC) of inhalational anesthetics.

• Increased volume of distribution for water-soluble drugs.

• Immature neuromuscular junction.

These features determine the specifics of strategy and techniques of anesthetic management, which is true for surgery of any volume and duration [4].

Features of anesthesia in pediatrics

Preoperative period

Talking to patient: Pediatric anesthesiologist's mastery starts from the skill of talking to a little patient before the surgery. Based on the age, past medical experience and psychological maturity, the child feels a certain fear of the upcoming operation [5]. While most adults are obsessed by thoughts of death, children are generally scared of pain and separation from parents. It may take a lot of time to calm down the frightened child, so the anesthesiologists has to give an understandable explanation of what the child has to face during the operation and anesthesia.

Premedication: There are many recommendations on premedication in children. Premedication is often omitted in newborns and infants. The exception is neonates and infants with congenital heart disorders who may be administered morphine sulfate (0.1 mg/kg IM) which prevents them from crying and, thus, precludes increased oxygen consumption, pulmonary hypertension, and cyanotic episodes. Anticholinergic drugs (for example, atropine – 0.01–0.02 mg/kg) are sometimes used before operation to decrease the risk of bradycardia and to prevent the excessive accumulation of secretion in airway which may be life-threatening due to small diameters of airway and endotracheal tube [6]. Accumulation of secretion is especially massive at concurrent upper respiratory tract infection or ketamine administration. Atropine is usually introduced IM, but oral or rectal administration is also possible. Atropine may also be introduced IV immediately before induction of anesthesia.

If after separation from parents from parents the child is more than likely to suffer agitation, then sedative drugs should be included in sedation. Several current research works are dedicated to oral premedication with sedative drugs combined with a small amount of some flavored drink; among the examples there are ketamine (6 mg/kg), midazolam (0.5 mg/kg), and chloral hydrate (50–100 mg/kg) [3, 4]. Intranasal administration of ketamine, midazolam, or sufentanil is also effective.

Induction of anesthesia

Anesthesia in children is induced either via IV catheter, or using inhalational anesthetics. Intramuscular induction of anesthesia (e.g., ketamine, 5–10 mg/kg) is recommended only in particular cases – for instance, in resisting agitated children. IV induction is better to be conducted in children taken to the operating room with IV catheter or in children who are quite communicative and bear well vein puncture or catheterization. The pattern normally used in adults is generally applicable: quick-acting barbiturate (e.g., thiopental – 3 mg/kg in newborns and 6 mg/kg in infants and older children) combined with non-depolarizing muscle relaxant [7]. Thiopental may be replaced with propofol (1.5–2.5 mg/kg) which better suppresses hypertensive response to endotracheal intubation, facilitates the postoperative emergence, and decrease the incidence of postoperative nausea and emesis [8]. There several advantages of IV induction of anesthesia over other methods: most anesthesiologists are well familiar with this technique; the method provides vascular access, so necessary drugs may be administered IV in case of emergency; fast induction is essential if risks of aspiration are high.

Most children are admitted to the operating

room without IV catheter, and they are generally scared of injections. EMLA cream being preliminary applied on the site of venipuncture relieves pain and, thus, significantly decreases possible stress for a child, parents, and anesthesiologist. However, EMLA is not such a perfect and trouble-free solution. Many children, especially those who were subjected to venipuncture a lot of time become very agitated at the sight of needle. Besides, it is difficult to tell beforehand where the site of successful vein catheterization will be located. Finally, EMLA should be spread on skin not later than 1 hour before venipuncture.

Modern powerful inhalational anesthetics allow anesthesiologist to turn the child unconscious in a few minutes. It is much more easy in children admitted to the operating room after administration of sedative drugs; their consciousness is already depressed, so they do not realize what is happening (unnoticeable induction of anesthesia).

First, the child is administered the odorless breathing mixture. Then breathing gas is supplemented with halothane [9, 10] or other inhalational anesthetic gradually increasing the concentration by 0.5 % every 3–5 inhales [11]. Desflurane and isoflurane have a stronger and more unpleasant smell than halothane and sevoflurane, and their application for induction is more likely to be associated with coughing, breath holding, and laryngospasm [12, 13]. When the patient turns unconscious the anesthetist catheterizes the vein and administers muscle relaxant.

Endotracheal intubation is also possible without muscle relaxant administration, though it requires much deeper anesthesia obtained by a gradual increase of inhalational anesthetic concentration. However, the absence of vascular access critical in the case of severe circulatory depression or laryngospasm is a grave disadvantage of this method. Laryngospasm occurring before catheterization should be treated by the IV administration of succinylcholine (4–6 mg/kg, but 150 mg max), and bradycardia is treated by the IM administration of atropine (0.02 mg/kg, 0.4 mg max) [14].

Maintenance of anesthesia

Anesthesia in children is maintained using the same anesthetics as in adults. Though in children MAC is higher than in adults, newborns are very sensitive to cardiodepressive effects of general anesthetics. During surgery non-depolarizing muscle relaxants are normally used [15].

Emergence and recovery

The most common postoperative complications in children include laryngospasm and postintubation croup. Postoperative pain in children should be managed with the same intensity as in adults.

Laryngospasm is a strong involuntary spasm of laryngeal muscles due to irritation of the superior laryngeal nerve. Generally, laryngospasm may be avoided by extubation either after emergence (spontaneous eye opening), or during deep anesthesia (spontaneous breathing, no cough). Each method has its adherents. *Extubation in the period between these two conditions is dangerous.* Laryngospasm management implies a delicate mask ventilation, mandibular advancement, lidocaine IV (1–1.5 mg/kg), small doses of rocuronium IV (0.4 mg/kg), and, finally, forced ventilation. If the vascular access is not obtained or the listed measures are ineffective, succinylcholine IM administration (4–6 mg/kg) is recommended [12, 16]. Laryngospasm tends to occur immediately after the surgery, but may also happen in postanesthesia care unit when the patient emerges and chokes due to accumulation of mucus in the larynx.

For that reason, children in postanesthesia unit are normally placed in a lateral position, so secretion is accumulated in the mouth and leaks outside and not towards the vocal folds. When the child regains consciousness in this position it is more comfortable and convenient for him/her to look at the parents sitting at the bedside.

Postintubation croup is associated with laryngeal or tracheal edema. The narrowest airway segment in children is the cricoid ring, and edema in this location is the most frequent cause of obstruction. If endotracheal tube is uncuffed and due to its size at the airway pressure increase to 10–25 mmH2O there was a small breathing mixture leakage then croup risk is small. *Postintubation croup risk factors include age of 1–4, multiple intubation attempts, too thick endotracheal tube, long-term surgical interventions, head and neck surgery, and excessive tube shifts in the trachea (for example, due to coughing or head movements before extubation). Edema prevention:* dexmethasone (0.1–0.5 mg/kg IV). Management: racemic epinephrine inhalation (0.5 mL of 2.25 % solution in 2.5 mL of normal saline). Though postintubation croup is believed to be a later complication than laryngospasm it more than often occurs in 3 hours after extubation [4, 5].

Postoperative pain management in children has become a subject of focus recently. Particularly, the usage of nerve block to manage pain is

being discussed. Another promising technique is patient-controlled analgesia which may be effective in children older than 6 years of age depending on their development and preoperative preparation [15].

Surgery types and preoperative preparation

All brain tumor surgery may be classified into three groups according to volume and specifics of surgery [1–3, 10, 15]:

1. Eradication of tumor (total or within visual field).
2. Partial removal.
3. Palliative surgery (ventricular drain insertion or decompressive craniectomy) [3].

Besides, in some cases children have to undergo the two-stage removal of tumor with 1–3-month period between the procedures.

These variants of surgery cause different traumatization and have different duration, but all of them are a challenge for anesthesiologist.

Based on the objectives of this review, it is more appropriate to classify the surgery under consideration into groups according to surgical modalities:

1. Shunt surgery.
2. Open surgery.
3. Neuroendoscopy.

Appropriate preoperative assessment and preparation does not only decreases risks related to the surgery itself and reduces possible critical situations during anesthetic management, but also helps patient in bearing both operation and postoperative period.

In children with brain tumors preoperative preparation is aimed at moderate dehydration and decrease of intracranial pressure (ICP), which reduces symptomatology and facilitates anesthetic management and surgery [17]. Such patients should be observed in neurosurgery department and immediately transferred to intensive care unit if their condition deteriorates.

Children with extensional brain neoplasms should not also be premedicated with sedative drugs as it may cause respiratory depression.

Anesthetic considerations for shunt placement or revision

The standard drainage procedure implies catheter insertion into one of cerebral cavities.

Anesthetic management for shunt surgery should consider the following:

• Subcutaneous shunt conduction is quite painful, so before the procedure the patient should be administered fentanyl IV (0.5 μg/kg) [8].

• During the surgery small children may be almost naked, so other parts of the body should be covered and warmed by the air [18]. The patient should never be exposed to cold.

• Shunt conduction may damage most of adjacent structures including the liver, pleura and lungs, neck vessels and nerves, and posterior cranial fossa [19].

• Anesthetist should make sure that the patient's condition in early postoperative period is not worse than before surgery. If condition deterioration is suspected the patient should be transferred to intensive care unit for further observation until the condition is stabilized.

Preoperative assessment and preparation in patients with hydrocephaly:

• Irrespective of clinical presentation it is accepted that ICP is increased in all patients requiring shunt surgery. In some patients ICP will be decreased while in others it may be normal.

• Neurological status should be appropriately assessed, i.e. according to the Glasgow Coma Scale, as well as lateralization signs, pupillary responses and reflexes.

• Many patients later have to undergo shunt revision, and it should be kept in mind that their condition may differ from the previous one.

• The cases when immediate drainage is required are considered a genuine emergency, and no delay due to excessive examinations is permissible.

Intraoperative problems in shunt surgery:

• Appropriate analgesia is necessary for craniectomy and especially for conduction of subcutaneous shunt guide.

• IV bolus injection of short-acting opioids such as fentanyl is possible.

• Intravenous and inhalational anesthesia is equally acceptable.

• Local anesthesia is used on the site of abdominal wall incision (at ventricular or lumboperitoneal shunting) to decrease the demand for painkillers in postoperative period.

• Surgery itself takes quite little time, and the experienced surgeon will deal with uncomplicated case for less than 30 minutes.

In infants and younger children:

• Anesthesia is based on the principles of anesthetic management for neurosurgery on small children.

• At subcutaneous conduction catheter may squeezes the chest in infants interfering with its normal movements. This stage should be reduced as much as possible.

Monitoring:

Special methods for monitoring in the described surgery are normally not applied, and control of general indicators is sufficient.

Postoperative period after shunt surgery:

• Complications after shunt surgery are rare, and patients with complications may be returned to neurosurgery unit immediately after the operation.

• Whenever any recovery problems occur the patient is assessed in order to detect the reasons of neurological deterioration (i.e., bleeding or convulsions) or disturbed shunt position.

• Light analgesia is usually sufficient; however some patients feel a significant paint after operation, mostly at subcutaneous tunneling, which may require the usage of strong opioids.

• External ventricular drainage is blocked or, more often, attached to manometer and draining system. Zero point is set at the level of acoustic duct. Drainage pressure is usually within the range of 50–150 mm H_2O.

Anesthetic considerations for open surgery

Main principles of neuroanesthesia are applicable in pediatrics.

Anesthetic management is aimed to provide optimal brain perfusion, appropriate surgical access and working mode [4, 15, 19].

• Premedication with sedative drugs is generally avoided due to risks of respiratory depression, hypercapnia, and potentially negative effect on ICP and airway patency.

• At high ICP it is recommended to use intravenous induction with intubation and ventilation maintaining at the lower limit of normal.

• At incomplete gastric emptying and risk of aspiration fast sequential induction and pressure in the cricoid may be applied.

Venous access may be only obtained if many factors are considered, and one of the main is the child's readiness to engage with anesthetists. Normally, the first procedure is fast induction with inhalational anesthetic followed by peripheral vein puncture and catheterization.

• At prone position of a patient, reinforced tubes are used; the tubes are stabilized with the help of pharynx tampons soaking in the secretion. At supine position, the possible alternative is a special RAE tube. Nasotracheal intubation is recommended in infants and children if intermittent positive pressure ventilation is planned after the surgery [2, 18].

• The child should be kept warm during the whole operation and positioning on the operating table; forced-air warming device is normally used.

• Large-diameter catheter should be inserted as there is a risk of unexpected bleeding.

• Nasogastric tube is generally used for induction of anesthesia during surgery for posterior fossa tumors in order to manage possible swallowing problems.

• Scope of stimulation depends on the stage of operation. Bridge or fixture placement is as painful as skin incision, shift of epicranial aponeurosis, and wound closure. Well-timed local anesthesia or systemic analgesia is necessary to prevent hypertension and exacerbation of brain edema. The following measures may be used:

– Local anesthesia of head skin after induction preserves stable functioning of the cardiovascular system.

– Local infiltration of head skin with anesthetics performed by surgeons is widely used.

• Most neurosurgery is performed with minimal blood loss. However, there is always a risk of fast unexpected hemorrhage, which means that a large-diameter venous catheter should be inserted [20]. Besides, the circulating blood volume in children is lower than in adults, and even insignificant blood loss badly affects the hemodynamics in pediatric patients. In order to prevent and manage such condition the operating room should be supplemented with compatible packed red blood cells ready for transfusion. The adequate evaluation of blood loss volume may be also complicated as blood is soaked by surgery garb and mixed with irrigating solutions [21].

Along with that, the excessive infusion of crystalloid solutions should be avoided as it may aggravate brain edema. At the same time, if osmotic diuretics are used in increased ICP management it is more difficult to calculate the required volume of infusion.

• Water depletion increases risks of hypovolemia and hypotension, so bolus injection of colloid solutions may be needed.

• Surgical procedures or decompression near (or involving) the brain stem or forth cavity may cause grave cardiovascular disorders, such as bradycardia, hypo- and hypertenstion, or arrhythmia.

It is almost impossible to take any precautions. The close cooperation between the anesthesiologist and surgeon is critical both for prevention of potential disorders, and for interruption of dissection if it is possible. If cardiovascular dysfunction is still preserved after the procedure has been stopped it indicates the serious neurological injury. After the operation such patients should be observed in intensive care unit.

Postoperative period

• Anesthesiologist should focus on the smooth emergence.

• Before emergence the patient should be administered antiemetics, pain relievers, and agents recovering neuromuscular conduction.

• The choice of pain reliever depends on the child's age, surgery duration, and preoperative conditions; the following moments should be considered:

– In early preoperative period paracetamol IV or short-acting opioids are used.

– Opioid analgesia is recommended after craniectomy or resection craniotomy [3]. Further bolus dose are specified and administered at emergence and in recovery period.

– Opioid analgesia may be continued as a patient-controlled analgesia, nurse-controlled analgesia, or orally in dependence on local protocols and monitoring of analgesia. Usually opioid analgesia may be stopped in 16–23 hours after the surgery and replaced with light oral painkillers. Exact recommendations on painkillers vary.

Monitoring for anesthesia in children with intracranial tumors

Traditional monitoring methods are supplemented with:

• Arterial catheterization for invasive pressure monitoring and perioperative arterial blood sampling.

• Body temperature monitoring.

• Bladder catheterization both for diuresis monitoring and for prevention of bladder distention at a long-term operation.

• Esophageal stethoscopes in infants and younger children, especially at a high risk of venous air embolism.

• Central venous pressure monitoring is not a routine method, but it should be used at a high risk of air embolism, estimated vast blood loss, or instability of the cardiovascular system.

• If blood loss is significant the frequent assessment of hemoglobin levels and blood coagulation system state is necessary.

Anesthetic considerations for neuroendoscopy

Shunt surgery and tumor biopsy sampling may involve neuroendoscopic techniques. Neuroendoscopic surgery uses rigid, semiflexible, or flexible endoscopes introduced into the skull cavity via trephine opening and then into brain cavity system via the brain parenchyma [19, 22]. Operations are conducted in the areas accessible via brain cavity system.

Preoperative assessment:

• Standard principles of evaluation before neurosurgery in children are applied.

• As in other surgery with a long-term intracranial hypertension the patients may suffer from undernutrition and dehydration.

• Symptoms of increased ICP or visual signs of tumor-induced mass-effect should make the anesthesiologist more attentive during the surgery, as they may be associated with instable cardiac activity caused by sudden changes in pressure between intracranial regions. Standard principles of neuroanesthesia are applied:

• If endoscopic ventriculostomy of the third cavity is prior to the formal examination of the posterior fossa then the appropriate anesthetic technique is used based on the situation and surgery plan.

• Intraoperative instability of the cardiovascular system, especially bradycardia, is mainly surgery-related and associated with excessive irrigation or diathermia-induced blockage of fluid output near sensitive areas.

• Intraoperative analgesia may involve fentanyl [8].

• In postoperative period, light oral analgesia may be sufficient [23]. However, it is strongly recommended to observe the patient in intensive care unit, at least during the first day after the surgery.

Monitoring:

The standard set of monitoring means and indicators is believed to be sufficient.

Emergence and early postoperative period

The emergence site (operating room or intensive care unit) is decided by anesthesiologist only [24, 25]. The following factors should be considered:

• Patient's condition before the surgery.

• Volume of the surgery.

• Intraoperative complications.

• Any problems during the anesthetic management [25].

• Patient's readiness for emergence (drug-induced depression, neuromuscular block, and spontaneous breathing) [26].

Emergence in the operating room is recommended when:

• Patient's condition before the surgery was good, without any significant disorders or abnormalities [27].

• Volume of the surgery was small.

• Both surgery itself and anesthetic management were uncomplicated [28].

• Stable spontaneous respiration and signs of emergence are observed [29]:

– BIS-monitor indicators showing the activation of nervous system;

– papillary reflex;

– coughing reflex;

– response to stimuli.

Emergence in intensive care unit is recommended when:

• Patient's condition before the surgery was critical [30]:

– impairment of consciousness;

– motor dysfunction;

– instable indicators of hemodynamics;

– disturbances of water-electrolytic balance induced by emesis, dehydration etc.

• Volume of surgery was significant (i.e., eradication of tumor).

• There was a vast intraoperative blood loss.

• Vital indicators (HR, BP, SpO2) are critically changed [31].

• Neurovegetative protection is necessary – particularly, due to large volume of the surgery or possible episodes of hypoxia during the anesthetic management [32].

All pediatric patients subjected to brain tumor surgery should be admitted to intensive care unit in early postoperative period (for 1 day minimum).

The observation is essential mainly because the central nervous system in children is still immature, so it may have an inadequate response to ICP changes, which in its turn may cause impairment of consciousness, respiratory and vasomotor depression, or malfunction of the central regulation of body systems and organs [33].

The following management is recommended in the conditions of intensive care unit:

• analgesia (methods and medicines are chosen in dependence on the patient's individual features);

• fluid therapy for correction of water-electrolytic balance and prevention of hypovolemia;

• brain edema preventing therapy involving hormones (prednisolone etc.);

• supportive care;

• antibacterial therapy (if needed) [34].

Conclusion

In last fifteen years the scope and assortment of new features of neurosurgery has grown – both in diagnosis and treatment. However, brain tumors are still considered a difficult entity encountered in clinical practice, especially in children.

For that reason, this pathology requires a careful attention of all specialists engaged in treatment. Brain tumor surgery is a true challenge for the whole operating team including neurosurgeons and anesthetists. Skilled anesthesiologist should not only take into account all the individual features of the certain patient, but also predict and prevent potential complications as soon as possible.

Cooperation of neurosurgeon and anesthesiologist is also a critical factor. If they are ready and able to cooperate, and if their collaboration is successful, the surgery outcome is very gratifying. However, more detailed research is required to reveal and assess all the psychological, ethical, and professional aspects of such cooperation.

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СПЕЦИФИКА ПРОВЕДЕНИЯ АНЕСТЕЗИИ У ДЕТЕЙ ПРИ ОПУХОЛЯХ ГОЛОВНОГО МОЗГА: СИСТЕМНЫЙ ОБЗОР

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Цель. Основываясь на обзоре публикаций, посвященных оказанию анестезиологического пособия при оперативных вмешательствах у детей с новообразованиями головного мозга, выявить и обобщить специфические особенности проведения анестезии у таких пациентов. **Материалы и методы.** Мы сделали системный обзор, обработав информацию из российских и зарубежных источников, изданных в период с 2001 по 2016 г. Анализировались данные о пациентах младше 18 лет, подвергшихся оперативному вмешательству в связи с опухолью головного мозга. **Результаты.** Проведенный анализ позволил подразделить оперативные вмешательства на три основные категории (шунтирующие операции, открытые вмешательства, нейроэндоскопические операции) и определить особенности анестезиологического пособия для каждой из категорий. Также был сформулирован алгоритм действий анестезиолога при подготовке пациента к операции, при пробуждении и в раннем послеоперационном периоде. **Заключение.** Обзор показал, что оперативные вмешательства при новообразованиях головного мозга относятся к наиболее сложным и требующим слаженной работы всей операционной бригады. Помимо высокой квалификации специалиста, проводящего анестезиологическое пособие, критически необходимо тесное сотрудничество анестезиолога и нейрохирурга. Психологические, этические и профессиональные аспекты такого сотрудничества должны быть изучены более подробно в дальнейших исследованиях.

Ключевые слова: *анестезиологическое пособие, детская анестезиология, пробуждение, предоперационная подготовка, хирургическое вмешательство, дети, новообразования головного мозга.*

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