Anesthesia for Nuclear Medicine Procedures in Children from 2002-2004 in Siriraj Hospital : A Retrospective Study

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บทคัดย่อ : **การให้ยาระงับความรู้สึกสำหรับการตรวจทางเวชศาสตร์นิวเคลียร์ผู้ป่วยเด็กในโรงพยาบาลศิริราช ตั้งแต่ปี พ.ศ. 2545-2547 : การศึกษาแบบย้อนหลัง**

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บทนำ : การทำหัตถการทางเวชศาสตร์นิวเคลียร์เป็นการตรวจวินิจฉัยความผิดปกติของอวัยวะต่าง ๆ ภายในร่างกาย การศึกษานี้เป็นการรวบรวมข้อมูลเกี่ยวกับการให้ยาระงับความรู้สึก **วัตถุประสงค์ :** เพื่อการศึกษาการให้ยาระงับความรู้สึก, ยาที่ใช้และภาวะแทรกซ้อนต่าง ๆ ที่เกิดขึ้นและเกี่ยวข้องกับการให้ยาระงับความรู้สึก **วิธีการศึกษา :** ศึกษาผู้ป่วยเด็กทั้งหมดที่มารับการให้ยาระงับความรู้สึกสำหรับการทำหัตถการทางเวชศาสตร์นิวเคลียร์ในโรงพยาบาลศิริราช ตั้งแต่ปี พ.ศ. 2545-2547 รวบรวมข้อมูลทั่วไปของผู้ป่วย ปัญหาก่อนการให้ยาระงับความรู้สึก วิธีการให้ยาระงับความรู้สึก ยาที่ใช้ ระยะเวลาการให้ยาระงับความรู้สึก ชนิดของหัตถการและภาวะแทรกซ้อนต่าง ๆ ที่เกิดขึ้น ประมวลและสรุปผลโดยใช้สถิติเชิงพรรณนา **ผลการศึกษา :** ผู้ป่วยทั้งหมด 195 ราย มีอายุระหว่าง 0-24 เดือน พบมากที่สุด (57.5%) ส่วนมากจะมี ASA class II (46.7%) การวินิจฉัยคือ neuroblastoma (25.1%), renal outflow tract obstruction (17.4%), vesico-ureteral reflux (14.4%), hydronephrosis (9.7%), urinary tract infection (6.2%) และอื่น ๆ พบว่าโรคเลือด, โรคระบบทางเดินหายใจ, โรคไตเป็นปัญหาก่อนการให้ยาระงับความรู้สึกมากที่สุด ได้รับการให้ยาระงับความรู้สึกด้วยวิธี total intravenous anesthesia มากที่สุด (87.7%) ผู้ป่วยส่วนมากได้ยา midazolam, propofol, ketamine ระยะเวลาการให้ยาระงับความรู้สึกเฉลี่ย 56.6 ± 29.7 นาที ชนิดของหัตถการคือ renal scan with DMSA (26.7%), bone scan (25.6%), bone scan และ MIBG (20.0%), renogram (16.9%), diuretic renal scan (5.6%) และอื่น ๆ (2.5%) ภาวะแทรกซ้อนที่เกิดขึ้นบ่อยที่สุดคือความดันเลือดต่ำ **สรุป :** การให้ยาระงับความรู้สึกในผู้ป่วยเด็กที่มารับการตรวจทางเวชศาสตร์นิวเคลียร์ไม่จำเป็นต้องใช้ยาหรือเทคนิคพิเศษอื่น แต่ผู้ให้ยาสลบต้องสามารถควบคุมผู้ป่วยให้อยู่ในภาวะที่สามารถทำหัตถการได้ด้วยความสะดวก และควรระมัดระวังภาวะแทรกซ้อนต่าง ๆ ที่อาจเกิดขึ้น

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Children frequently require sedation to facilitate outpatient diagnostic imaging procedures such as nuclear medicine procedures, magnetic resonance imaging (MRI) or computed tomography (CT). Limitations in health care resources and personnel have made it difficult to monitor these children for prolonged periods. In many instances, the nurse in charge of monitoring recovery of one child is also responsible for sedating and monitoring the next child. Therefore, despite nationally recommended discharge criteria,[1] children are often sent home into the care of their parents after a brief recovery. Nuclear medicine procedure is a procedure for diagnosis of the abnormality of different body parts and usually performed outside operating room where there are limitations in health care resources and personnel. In Siriraj Hospital, the management of acute pain and anxiety in children undergoing therapeutic and diagnostic procedures outside the operating room has developed substantially in the past ten years. The widespread availability of noninvasive monitoring, short-acting opioids and sedatives, and specific opioid and benzodiazepine antagonists has enabled clinicians to administer anesthesia safely for procedures in diverse settings. The choices and techniques of anesthesia and drug selection vary according to the condition of the patients and familiarity of the anesthesiologists. Therefore, we conducted this retrospective study to examine the choices and techniques of anesthesia, drug usage and complications which occurred during that period of time in order to adapt and keep the data for further research in the near future.

Material and Method

Data from anesthetic, procedure records and history charts of patients who underwent nuclear medicine procedures in Siriraj Hospital from November 1,st 2002 to October 31,st 2004 were reviewed. The general data included sex, age, ASA physical status, body weight, diagnosis and nuclear medicine procedures. The anesthetic data encompassed pre-anesthetic problems, premedications, choice of anesthesia, variety of drug usage, monitoring agents, time and complications evolved intraoperatively.

Descriptive statistics such as mean ± SD or percentage (%) were used to summarize the results, when appropriate.

Results

Nuclear medicine procedures were performed in 195 children during the study period. The majority of them were male and in ASA physical status I-II. Most of patients were in the groups of age below 24 month-old (57.5%) and the range of body weights between 5.1 to 15 kg (78.9%) (Table 1).

The majority of diagnoses included neuroblastoma, renal outflow tract obstruction and vesico-ureteral reflux (VUR). Other diagnoses were hydronephrosis, urinary tract infection (UTI), rhabdomyosarcoma, retinoblastoma, retroperitoneal mass, anorectal malformation and others ; end-stage renal disease (ESRD), hepatoblastoma, etc as shown in Table 2.

Ninety three out of 195 patients (47.7%) presented with pre-anesthetic medical problems ; i.e. hematologic diseases (47.3%), respiratory diseases (11.8%), renal diseases (10.8%), metabolic disorders (8.6%), cardiovascular diseases (7.5%), genetic diseases (6.4%), central nervous system diseases (5.4%) and others (2.2%).

Almost all of the procedures were carried out under total intravenous anesthesia technique (87.7%), monitored anesthesia care (8.7 %), general anesthesia with either endotracheal intubation or mask (3.6%) The details of sedative agents and narcotics are shown in Table 3.

Clinical monitoring observed by the anesthetic personnel consisted of non-invasive blood pressure, pulse oximetry and electrocardiography. The anesthetic duration ranged from 15 to 180 minutes. The mean anesthetic time was 56.6 ± 29.7 minutes as shown in Table 4. The nuclear medicine procedures were renal scan with DMSA (26.7%), bone scan (25.6%), bone scan and MIBG

Table 1 Patient' s characteristics

Characteristics	Number	%
Sex		
Male	124	63.6
Female	71	36.4
Age (months)		
0-12	76	39.0
13-24	36	18.5
25-36	29	14.9
37-48	31	15.9
49-60	13	6.7
61-72	8	4.1
> 72	2	1.0
ASA physical status		
I	87	44.6
II	91	46.7
III	17	8.7
Body weight (kg)		
0-5.0	12	6.2
5.1-10.0	77	39.5
10.1-15.0	77	39.5
15.1-20.0	19	9.7
20.1-25.0	4	2.0
25.1-30.0	5	2.6
30.1-35.0	1	0.5

Table 2 Diagnoses of the patients

Diagnoses	Number	%
Neuroblastoma	49	25.1
Renal outflow tract obstruction	34	17.4
Vesico-ureteral reflux	28	14.4
Hydronephrosis	19	9.7
Urinary tract infection	12	6.2
Rhabdomyosarcoma	8	4.1
Retinoblastoma	5	2.6
Retroperitoneal mass	5	2.6
Anorectal malformation	4	2.0
Others	31	15.9

Table 3 Anesthesia related data

Data	Number	%
Anesthetic technique		
Total intravenous anesthesia	171	87.7
Monitored anesthesia care	17	8.7
General anesthesia with endotracheal intubation	4	2.1
General anesthesia with mask	3	1.5
Sedative agents		
Midazolam	149	37.3
Propofol	144	36.1
Ketamine	51	12.8
Chloral hydrate	30	7.5
Narcotic		
Fentanyl	25	6.3

Table 4 Anesthetic time

Duration of time (min)	Number	%
< 30	6	3.1
30-59	117	60.0
60-89	35	17.9
90-119	27	13.9
> 119	10	5.1

Table 5 Nuclear medicine procedures

Procedures	Number	%
Renal scan with DMSA	52	26.7
Bone scan	50	25.6
Bone scan and MIBG	39	20.0
Renogram	33	16.9
Diuretic renal scan	11	5.6
Renal scan with DMSA and renogram	3	1.5
Others	7	3.5

(20.0%), renogram (16.9 %), diuretic renal scan (5.6%) and others (2.5%) as shown in Table 5.

The most frequent anesthetic complication was hypotension (2.6 %) which was promptly corrected by the administration of vasopressor and fluid loading, tachycardia (1.0%) and upper airway obstruction (0.5%). Other late complications included motor imbalance, agitation or restlessness and GI disturbance

Discussion

A nuclear medicine scan uses a camera that takes pictures of the inside of patient body. It takes pictures of different parts of the body like heart, kidneys, lungs, bones or liver. In our department, examinations of many procedures are performed without sedation. It is exceptional that a test has to be postponed because of lack of cooperation by the patient. Good quality images, taking into account the recommended pediatric amounts of radioactivity, are achieved for procedures such as MIBG whole body scanning (10 min frame-1), gastro-esophageal reflux studies (60 min acquisition), renography and furosemide challenge (45 min) or pinhole views for bone or renal DMSA studies (20-30 min). Sedative drug remains in some conditions the only way to obtain a satisfactory nuclear medicine examination in children.[2]

Sedation of the pediatric patient for nuclear medicine imaging procedures requires careful planning, patient preparation and monitoring to ensure patient safety. The American Academy of Pediatrics guidelines for the safe use of sedation recommend a systematic plan for the use of sedative agents. Elements of the plan include informed consent, a patient pre-sedation health evaluation, monitoring by a cardiopulmonary resuscitation-trained health-care practitioner and recovery of the patient to the pre-sedation state before discharge. Other considerations include the formation of a sedation committee to monitor the sedation program as well as provision of adequate space and equipment to monitor and care for patients appropriately.[3]

The two basic choices of anesthesia in non-cooperative children undergoing a procedure, which have advantages and disadvantages, are total intravenous anesthesia and general anesthesia. With the total intravenous anesthesia techniques, the authors can reduce anesthetic agents and the patients would gain a rapid recovery, but it is very difficult to control respiration and hemodynamic. While the general anesthesia technique, the control of respiration and cardiovascular systems are more reliable. In our institute, the authors normally use total intravenous anesthesia because of the given reasons in conjunction with the preference of anesthesiologists.

There are no special anesthetic techniques needed for this kind of anesthesia. The indication for providing general anesthesia was mainly related to the underlying disease. Cardio-pulmonary disease have been regarded as the major risk factors for complications associated with anesthesia. However, it depends on the experience of the anesthesiologists themselves.

The choice of sedation should be based on a predetermined sedation formulary and the assessment of the patients' physical status. The progression from mild sedation to general anesthesia is not easily divided into discrete stages. Low doses of opioids and sedative-hypnotic agents induce mild analgesia and sedation, respectively, with minor adverse events. As the dose increases and the level of drug in the central nervous system rises, consciousness decreases and the risk of cardiorespiratory depression increases. As the dose increases further, the patient continues to advance along the sedation continuum until protective airway reflexes are lost and general anesthesia is reached. This continuum is not drug-specific, since various states, from mild sedation to general anesthesia, can be achieved with essentially all sedative agents.[4]

Sedation must be administered by personnel capable of rapidly identifying and treating cardiorespiratory complications, including respiratory depression, apnea, partial airway obstruction, emesis and hypersalivation. They must understand the pharmacology of the

sedatives they use and be proficient at maintaining airway patency and assisting ventilation if needed. At least two experienced persons are required, usually a physician and an assistant such as a nurse or respiratory therapist. The physician typically oversees drug administration and then performs the procedure, while the assistant continuously monitors the patient for complications and documents the medications administered, the response to sedation and periodic vital signs. The assistant may perform minor, interruptible tasks, but the assistant's ability to remain focused on the patient's cardiopulmonary status must not be impaired.[5] It is strongly recommended that a person trained in advanced life support be available when primary sedation is administered ; it is mandatory that such a person be available when deeper sedation is likely or possible.

Appropriate monitoring of sedated children has permitted early detection of adverse events and aversion of life-threatening sequelae from current sedation regimens.[6] However, the ideal sedative drug with properties including rapid onset, consistency of effects, controllable duration of action, few side effects, minimal respiratory depression, and above all, safety remains to be identified. Although the intravenous anesthetic agent propofol possesses some of these properties, it can produce profound respiratory depression and loss of protective airway reflexes making it suitable for use only by persons trained in the administration of general anesthesia.[7] Therefore, future efforts toward enhancing the safety of sedated children must include development of newer sedation regimens and specific evaluation and comparison of such regimens to permit identification of the most effective sedation technique with the least side effects.

In our experience, the combination of midazolam and ketamine provides safe, effective sedation for procedures in children. With newer short-acting agents such as midazolam, propofol, fentanyl and ketamine have been used to provide preanesthesia and procedural sedation in children with good results. In general, all of these agents have been shown to be both effective and relatively safe when used with appropriate monitoring.[8]

One of the oldest drugs, oral chloral hydrate has a well-established safety profile.[9,10] It has no analgesic properties and its use is now mainly restricted to diagnostic imaging particularly in children under three years of age. Midazolam can be administered by multiple routes. It provides potent sedation, loss of memory and anxiolysis. Caution must be exercised when using midazolam and opioid together, since the risks of hypoxia and apnea are significantly greater than when either is used alone.[11,12] The effects of midazolam can be reversed with the antagonist flumazenil.

When given parenterally (intramuscularly or intravenously), ketamine rapidly induces a trancelike cataleptic condition characterized by profound analgesia, sedation, amnesia and immobilization.[13-15] It preserves upper airway muscular tone and protective airway reflexes. Although unpleasant hallucinations and dreams during the recovery period have substantially limited the use of ketamine in adults, such dysphoric emergence reactions are rarely noted in children.[13] Propofol has theoretical promise for procedural sedation, since the dose of these drugs can be rapidly titrated to produce a desired depth of sedation and recovery is very rapid. However, there appears to be a higher likelihood of inadvertent over sedation and rapid swings in consciousness with propofol than with other agents, especially when they are administered by clinicians with limited training and experience in their use.[16]

All patients must be monitored until they are no longer at risk for cardiorespiratory depression. Before discharge, children should be alert and oriented (or have returned to an age-appropriate base line), and their vital signs should be stable and at base-line levels.[5] Many hospitals use recovery scoring systems similar to those used in their surgical postanesthesia recovery areas. If the child is an outpatient, a responsible adult must be present to observe the child for complications after discharge.

This adult should be given written instructions on appropriate diet, medications and level of activity.

In one study demonstrates that children may experience prolonged recovery as well as a significant incidence of delayed side effects after sedation for a diagnostic procedure. Specifically, they found a high incidence of motor imbalance, agitation, gastrointestinal effects and restlessness after discharge. Factors related to these side effects include younger age (restlessness and prolonged imbalance) and use of chloral hydrate (agitation and motor balance). Failed sedation and agitation contributed significantly to parental dissatisfaction with the child's sedation experience. These findings highlight the importance of careful presedation education and preparation of the patient/family regarding the potential for delayed recovery, anticipated side effects, and how to obtain medical follow up if necessary.[6] The second study shows that adverse sedation events were frequently associated with drug overdoses and drug interactions, particularly when three or more drugs were used. Adverse outcome was associated with all routes of drug administration and all classes of medication, even those (such as chloral hydrate) thought to have minimal effect on respiration. Standards of care, scope of practice, resource management and reimbursement for sedation should be based on the depth of sedation achieved (ie, the degree of vigilance and resuscitation skills required) rather than on the drug class, route of drug administration, practitioner or venue.[17]

Conclusion

Nuclear medicine procedure is a procedure for diagnosis the abnormality of different parts of the body. This procedure in children still needs not only physicians but also anesthetic personnel to observe and take care. Clinical signs should be carefully observed although the occurrences of complications have no statistical significance with the anesthetic technique. There was no need for special techniques or drugs in anesthesia but anesthetic personnel had to optimize the patient's condition for the safety and there should be an awareness of complications.

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Anesthesia for Nuclear Medicine Procedures in Children from 2002-2004 in Siriraj Hospital : A Retrospective Study

Abstract

Background : Nuclear medicine procedure is a procedure for diagnosis of the abnormality of different parts of the body. The authors studied anesthetic data as a basis for further research. ***Objective :*** To report and evaluate the choices and techniques, drug usage and complications of anesthesia for nuclear medicine procedures in children form 2002-2004 in Siriraj Hospital. ***Method :*** Retrospectively analyzed the patients on whom nuclear medicine procedure had been performed during the period of November, 2002 to October, 2004 in Siriraj Hospital. The patients' characteristics, preanesthetic problems, anesthetic techniques, agents, and time, as well as nuclear medicine procedures and their complications were assessed and summarized by using descriptive statistics. ***Results :*** During the study period, there were 195 patients receiving, nuclear medicine procedures ; i.e. renal scan with Dimercaptosuccinic acid (DMSA) (26.7%), bone scan (25.6%), bone scan and Metaiodobenzylguanidine (MIBG) (20.0%), renogram (16.9%), diuretic renal scan (5.6%) and others (2.5%). The majority of them were in the age group of 0-24 months (57.5%) and classified in ASA class II (46.7%). The diagnosis were neuroblastoma (25.1%), renal outflow tract obstruction (17.4%), vesico-ureteral reflux (14.4%), hydronephrosis (9.7%), urinary tract infection (6.2%) and others (27.2%). Most common preanesthetic problems were hematologic, respiratory and renal diseases. Total intravenous anesthesia (TIVA) was the main anesthetic technique in 87.7% of the patients. The mainly used anesthetic agents were midazolam, propofol and ketamine. The mean anesthetic time (SD) was 56.6 (29.7) minutes. The most frequent anesthetic complication was hypotension. ***Conclusion :*** During anesthetic management for nuclear medicine procedure, special techniques or drugs in anesthesia are not routinely required, however, the anesthetic personnel had to optimize the patient's condition for safety and beware of complications.

Keywords : *Nuclear medicine procedure, Anesthetic management, Anesthetic technique, Complication*