



Current Pediatric Anesthesia Practice in General in China: A National Survey

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Abstract

Background: The aim of this national survey was to document the current trends in pediatric anesthesia practice in China. The results may be used as a benchmark for future comparisons and evaluation of pediatric anesthesia practices in China.

Methods: A survey was sent to all members of anesthesiologists by WeChat. The respondents can choose whether to use mobile device or desktop to complete the survey. Each IP address is allowed to complete the survey once.

Results: A total of 5779 members read invitations. Of those 5779 recipients, 2496 responded with fully completed questionnaires, which represented an overall response rate of 43%. The three most common specialties were orthopedic surgery, otorhinolaryngology surgery, general surgery. Almost 19% of the respondents did not administer preoperative medications. Cuffed tracheal tube was applied more frequently in children older than the age of one. The most commonly used neuromuscular blockade agent was Cisatracurium. Remifentanyl was the most commonly used narcotic in surgery. More than 95% of the respondents did not routinely use neuromuscular monitors. More than 70% of the respondents did not routinely use reversal agents at the end of a surgical procedure.

Conclusions: This is the first pediatric anesthesia survey in China. The study revealed several potential pediatric anesthesia safety issues. The results can serve as a basis for future pediatric anesthesia studies. The results can help anesthesiologists to design pediatric anesthesia services and research projects.

Keywords

Pediatric anesthesia, Survey, China

Background

Pediatric anesthesia care is challenging for anesthesiologists. The morbidity and mortality in surgical patients under the age of ten, especially infants, has been significantly higher than adults [1,2]. Pediatric anesthesia is considered a fairly new specialty in China. The National Subcommittee of Pediatric Anesthesia was first

formed in 1984 [3]. Therefore, national data of pediatric anesthesia practice is scarce. We conducted a survey in China to help deliver data to compare hospitals at different level, identify drawbacks, conduct research, and ultimately, improve clinical practices.

This survey is the first study in China to document the trends in pediatric anesthesia practice. The data may be applied as a point of reference for future study of pediatric anesthesia practices in China.

Methods

More than 150,000 anesthesiologists are registered as members in the New Youth Anesthesia Forum. After the research committee of New Youth Anesthesia Forum approved, a survey was sent to all colleagues by WeChat using the WenJuan.com software. The respondents can complete the survey by using a mobile device or desktop. One participant can only complete the survey once.

The authors designed these questions based on their experience, suggestions from colleagues at different hospitals, and the combination of the information which was presented by recent research. The survey questions mainly focus on preoperative and intraoperative anesthesia care. This survey evaluated the respondent's hospital level (Level I, II, III), title, working experience, types of practice. Questions were further divided by different age groups categorized which were as the following: newborn (< 1-month-old), infants (≤ 12-months-old), toddlers (13-months-old to 3-years-old), preschool (3-7 years-old) and school children (> 7-years-old).

In order to minimize the bias in answers, we used these question structures: check boxes for Yes or No, choice of the single answer out of 2-5 selections. The survey had 38 questions. Uncompleted forms were discarded so that results only consisted of completed forms. Limited amount of anesthesia books was provided to encourage participation in this survey.

Chi square test was used for statistical analyses. All tests were 2-tailed with a type I error rate of 0.05.

Results

The survey was open from May 9, 2017 to June 8, 2017. The New Youth Anesthesia Forum delivers new notes to every member daily. The members browse the posts that they are attracted. The server can identify who has read the message. Only those anesthesiologists who browse the note were entered in the study. A total of 5779 members reviewed the survey. Out of those members, 2496 responses fully completed questionnaires. Therefore, overall response rate was 43%.

Table 1: Participants' demographic data.

Hospital	N (%)
Level I General Hospital	59 (2.36%)
Level II General Hospital	1004 (40.22%)
Level III General Hospital	1241 (49.72%)
Children Hospital	58 (2.32%)
Hospital for Women and Babies	134 (5.38%)
Physician title	
Resident Physicians	942 (37.74%)
Attending Physicians	1073 (42.99%)
Chief Physicians	481 (19.27%)
Hospital administration type	
Private hospital	244 (9.78%)
Public hospital	2252 (90.22%)
Participant's working experience	
< 5 years	571 (22.88%)
5-10 years	791 (31.69%)
11-20 years	791 (31.69%)
> 20 years	343 (13.74%)
Percent of pediatric anesthesia cases each year	
> 90%	75 (3%)
50-90%	63 (2.52%)
10-50%	972 (38.94%)
< 10%	1386 (55.53%)

The participants' demographic data are shown in **Table 1**.

The respondents were from different parts of the country (**Figure 1**).

Types of pediatric surgery and age of the patients

The three most common surgical specialties were orthopedic surgery, ENT surgery, general surgery. **Figure 2** showed different age groups of pediatric surgical patients under anesthesia care by the respondents. The most common age group of pediatric surgical patients are children between the age of 3-7 (preschool). The respondents could choose multiple answers in these two questions.

Routine pediatric premedication

Almost 19% of the respondents did not routinely administer pediatric premedications. Preoperative medications were given by different routes in China (**Table 2**). The three most commonly used routes of preoperative medication administration are intravenous (IV), intramuscular (IM), and nasal.

Induction

Most newborn, neonatal children received inhalation induction (68.07% and 62.06%, respectively), whereas preschool, school aged children received intravenous induction (75.56%, 92.71% respectively) (**Table 3**). The frequency of inhalation (47%) and intravenous (53%) induction for infants children were similar (**Table 3**).

The common induction agents were Sevoflurane (41.15%), Propofol (30.85%), and Ketamine (25.16%) (**Table 2**).

Narcotics: The most frequently used opioids during surgery was remifentanyl. Other opioid such as fentanyl

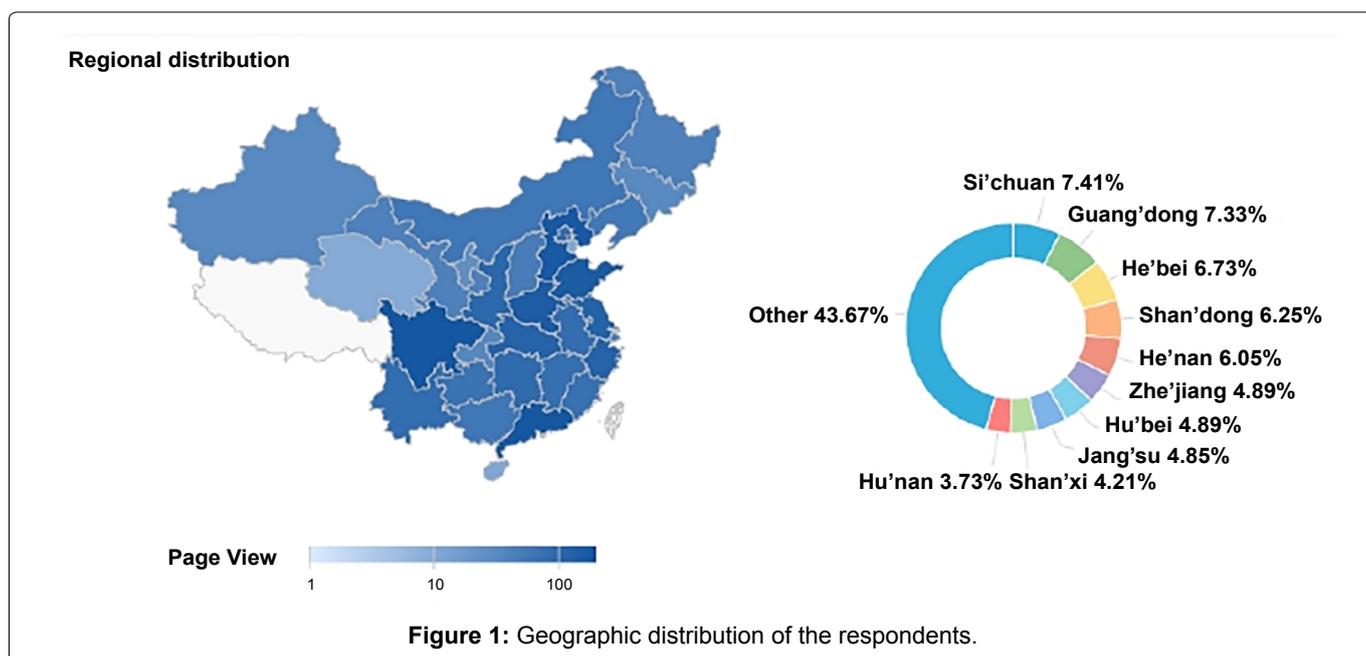


Table 2: Preoperative medication route, induction, maintenance, monitoring, anesthetic adjuvants, analgesia techniques.

Preoperative	N (%)
What is the common route of preoperative medication administration for children?	
Oral	70 (2.8%)
IM injection	775 (31.05%)
Intravenous	1050 (42.07%)
rectal	23 (0.92%)
Nasal	104 (4.17%)
No medications	474 (18.99%)
Do you allow parental presence during induction	
Yes	812 (32.5%)
No	1684 (67.5%)
Intraoperative	
Anesthetic agents	
What is the common induction agents for children	
Sevoflurane	1027 (41.15%)
Propofol	770 (30.85%)
Ketamine	628 (25.16%)
Etomidate	60 (2.4%)
Others	11 (0.44%)
What is your maintenance method during anesthesia	
Intravenous anesthesia	1143 (45.79%)
Inhalation anesthesia	1353 (54.21%)
Do you use N₂O during inhalation anesthesia	
Don't use N ₂ O, because N ₂ O was unavailable	2210 (88.54%)
Don't use N ₂ O, although N ₂ O was available	222 (8.89%)
Use N ₂ O	64 (2.56%)
What kind of Intraoperative narcotics do you use during anesthesia for children?	
Remifentanyl	1036 (41.51%)
Fentanyl	944 (37.82%)
Sufentanyl	514 (20.59%)
Morphine	2 (0.08%)
Intraoperative monitoring	
Pulse oxygen saturation monitoring is routinely used for all anesthesia patients?	
Yes	2465 (98.76%)
No	31 (1.24%)
EtCO₂ monitoring is routinely used for all anesthesia patients?	
Yes	2133 (85.46%)
No, because EtCO ₂ monitor was not available	244 (9.78%)
No, thought EtCO ₂ monitor was available	119 (4.77%)
Neuromuscular blockade	
Do you routinely use muscle relaxant before intubation	
Yes	2122 (85.02%)
No	374 (14.98%)
Do you routinely use nerve stimulator to monitor muscle relaxants	
Yes	106 (4.25%)
No, thought nerve stimulator was available	406 (16.27%)
No, because nerve stimulator was unavailable	1841 (73.76%)
No, because nerve stimulator was unnecessary	143 (5.73%)
Do you routinely use reversal agents before extubations	

Yes	743 (29.77%)
No, although reversal agents were available	1729 (69.27%)
No, because reversal agents were unavailable	24 (0.96%)
Anesthetic Adjuvants	
Do you routinely use Anti-emesis drugs for children?	
Yes, routinely used for children under GA	913 (36.58%)
No	557 (22.32%)
Use only when patient is at high-risk of postoperative nausea vomiting	1026 (41.11%)
Postoperative	
What kind of regional anesthesia techniques do you use in combination with general anesthesia	
Epidural anesthesia (excluded caudal)	219 (8.77%)
Caudal	840 (33.65%)
Peripheral nerve block	537 (21.51%)
Local infiltration	900 (36.06%)

and sufentanyl were also administered during pediatric surgery (Table 2).

Airway management: The frequency cuffed tracheal tubes (CET) and uncuffed tracheal tubes (UET) in surgery differed with the patient's age: UET was used more frequently in newborn and neonatal children, CET was applied more frequently in children > 1-year-old (Table 3).

Maintenance

Inhalation anesthesia (54.21%) was used more frequently to maintain anesthesia in pediatric surgery than intravenous anesthesia (45.79%) (Table 2).

N₂O use

Nitrous oxide was not used by the majority of respondents. Most of them (88.54%) did not use N₂O because their operating rooms did not have N₂O. Only 8.89% of the respondents said that they did not use N₂O although nitrous oxide was available in their operating rooms (Table 2).

Anesthetic adjuvants

Antiemesis agents: 36.58% of the respondents routinely used antiemesis agents when patient received GA. 41.11% said that they used antiemesis agents for patients with potential high risk of postoperative nausea vomiting (PONV) (Table 2).

Neuromuscular blockade, monitoring and reversal

Cisatracurium was the most popular NDMR for all age group pediatric patients. Rocuronium was the next most preferred NDMR (Table 3).

Majority respondents did not use a peripheral nerve stimulator, 73.76% did not have access to quantitative TOF monitors, and 16.27% did not use it even they had access to quantitative TOF monitors. Finally, 5.73% did not use it because they believed quantitative TOF mon-

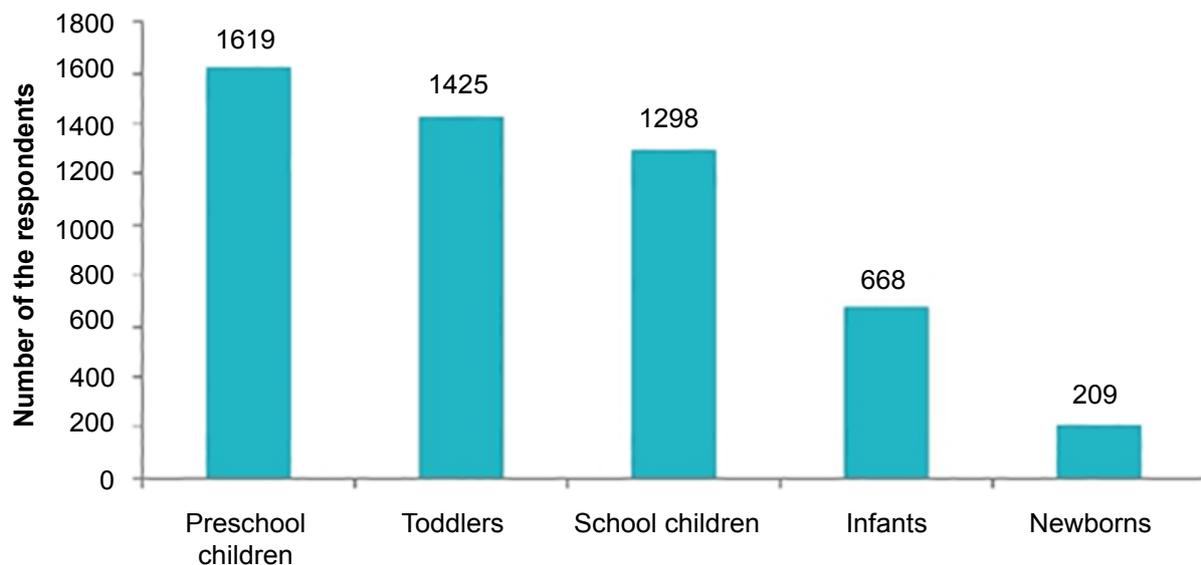


Figure 2: Age groups of pediatric surgical patients.

Table 3: Induction techniques, use endotracheal tube and muscle relaxant among different age group patients.

	Newborn (< 1 mo)	Neonatal (1 mo -1 yr)	Infant (1-3 yr)	Preschool (3-7 yr)	School (> 7 yrs)
What is Induction method for children?					
Inhalation induction	1699 (68.07%)	1549 (62.06%)	1173 (47%)	610 (24.44%)	182 (7.29%)
Intravenous induction	797 (31.93%)	947 (37.94%)	1323 (53%)	1886 (75.56%)	2314 (92.71%)
What type of Endotracheal tube do you use for children?					
UETs	1934 (77.48%)	1733 (69.43%)	949 (38.02%)	288 (11.54%)	16 (0.64%)
CETs	562 (22.52%)	763 (30.57%)	1547 (61.98%)	2208 (88.46%)	2480 (99.36%)
How do you extubate patient					
Deep extubation			880 (35.26%)	665 (26.64%)	
Awake extubation			1616 (64.74%)	1831 (73.36%)	
What kind of Muscle relaxants do you use during anesthesia for children					
Succinylcholine	134	121	64	44	21
Rocuronium	328	408	473	503	549
Cisatracurium	1140	1314	1475	1557	1563
Others	267	313	354	350	341
No muscle relaxants	627	340	130	42	22

itors was unnecessary (Table 2).

Nearly 70% the respondents reported that they did not routinely administer an anticholinesterase to reverse non-depolarizing relaxant. Less than 1% did not use because their OR did not have reversal agents (Table 2).

Intraoperative monitoring

Of the respondents, 99% of them routinely used the pulse oxygen saturation monitoring. More than 85% of the respondents reported that they routinely used end tidal carbon dioxide (ETCO₂) monitoring for their pediatric patients under general anesthesia. Of those, 4.77% reported they did not have end tidal carbon dioxide (ETCO₂) monitors in their hospitals (Table 2).

Extubation techniques: The majority of the respondents (> 64%) preferred tracheal extubation after the patient was fully awake (awake extubation) for children older than over the age of one. Some anesthesia provid-

ers did tracheal extubation while the patient was anesthetized (deep extubation) (Table 3).

Regional anesthesia: Regional analgesic techniques were used by anesthesiologists, as listed in Table 2. Almost 34% of the respondents used caudal anesthesia, 21.51% used peripheral nerve block, 8.77% used epidural anesthesia (except caudal), and 36.06% used local infiltration.

Children hospitals vs. General hospitals

When the respondents were stratified by hospital types, induction techniques, there were significant difference between Children's hospital group and general hospital group (P < 0.05) (Table 4). IV induction was used more frequently in newborns, infants, toddlers, preschool children, but not school children in Children hospitals than in General hospitals.

Discussions

Table 4: Comparison of induction methods between Children's hospitals and General hospitals.

	Neonatal	Infants	Toddlers	Preschool	School
Children's Hospitals					
IV induction	85	116	143	169	182
Inhalation induction	107	76	49	23	10
General Hospitals					
IV induction	712	831	1180	1717	2123
Inhalation induction	1592	1473	1124	587	172
P value	0.0002	< 0.0001	< 0.0001	< 0.0001	0.3119

Tencent in China developed WeChat as a free instant messaging application for mobile phone. WeChat has been used widely in almost every field of information service. Currently more than 600 million people use WeChat. It becomes a new tool to perform surveys for health care providers. More than 150,000 registered as members in the New Youth Anesthesia forum. Every member can get the survey invitation by WeChat. The application can determine who read the message and assess their locations. Therefore, the response rate can be calculated [4]. Hazard Munro suggested that the equation for determining the number of responses needed is ten times the number of questions [5]. We had 38- question in this survey, at least 380 responses were needed. Total 2496 responses were collected in this study. The participants were located every province in China.

Before 1980, pediatric surgical emergencies accounted for most of pediatric surgical procedures in China [6]. Gradually, elective pediatric surgeries were increased. Pediatric surgical subspecialties were established in many cities. In the 1990s surgical outcomes in China were not worse than in developed countries [6]. Pediatric anesthesia is also developing with pediatric surgery in China. In the mid-1980s, the first official national pediatric anesthesia society was established. This was the beginning of the first recognized subspecialties in anesthesiology. The first annual society meeting was organized in 1985 [3]. The meetings attracted many clinicians, educators, and researchers from across the country. They presented their work and challenges to each other. The process of learning, teaching, and collaborating advanced the perioperative care of children. The education and training of anesthesia providers, anesthesia equipment and techniques have been advancing significantly since 1980s. However, research in pediatric anesthesia is still behind adult anesthesia [3]. Therefore, we conducted this survey to evaluate the current pediatric anesthesia practice in China. The research can identify the current state of pediatric anesthetic practice in China. We hope this data will be supportive in pediatric anesthesia services and research projects development. The study is a relatively comprehensive national picture of pediatric anesthesia practice in general, particularly in general anesthesiologists.

We have identified the most frequent pediatric op-

erative procedures in China. The most frequent all-listed pediatric surgical specialties in China included orthopedic, ENT, general, eye, dental, plastic, cardiac, and radiologic surgery. The results indicated that majority of pediatric anesthesia were provided by general anesthesiologists, and a very small amount (3%) of the respondents only did pediatric anesthesia. In 2015 the Chinese health administration planned to establish nationally standardized residency training programs for medical graduates entering medical practice [7]. The standard of anesthesiology training is in the very early stages of development. The data may help the planning of training, especially the case number requirement for pediatric anesthesia.

Anesthesia induction is a tense activity for many children and their parents [8] Preoperative sedative drugs are routinely recommended to manage the anxiety of pediatric patients. Parental presence during induction of anesthesia (PPIA) has been used for anxiety control. In our survey, more than 80% of the respondents routinely applied pre-medication to control anxiety in children. Almost 68% of the respondents did not allow parental presence during induction. A recent Cochrane review demonstrated that PPIA did not affect pediatric patients' anxiety and cooperation during anesthesia induction, patient satisfaction, time for induction, or patient recovery quality [9].

Anesthesia techniques were significantly different between kids and adults. An inhalational induction was preferred for newborn and neonatal children but not in infants, preschool age children, or school age children. Inhalation induction seems to not be welcomed in China even for infants. In addition, N₂O was not available in the majority of operating rooms. The health care providers were concerned for nitrous oxide pollution in operating room and the effect of occupational hazards.

Uncuffed tracheal tubes (UTT) are commonly applied for the airway management in infants and children under the age of 8. A new study demonstrates that the majority of anesthesiologists use CTT in children of 2 years undergoing elective surgery [10]. Our survey showed that CTT was commonly used for infants, preschool age children, and school age children. The result is consistent with Sathyamoorthy's data [11], and supported the statement which said that there was a global

trend in pediatric anesthesia with a move towards the use of CTT in younger pediatric patients.

The most commonly used NMBD for tracheal intubation in pediatric patients in China is Cisatracurium. Cisatracurium had many pharmacological advantages over other steroid based NMBA, because of the unaffected volume of distribution, clearance and potency over a wide variety of clinical conditions, faster from the neuromuscular blockade [12].

It is a common practice that muscle relaxants are often used without monitoring. Surveys in Europe (Denmark, Germany, UK) [13-15], and Mexico [16] indicated that only 43%, 28%, 10%, and 2% of anesthetists, respectively, usually apply neuromuscular monitors when patients receive general anesthesia. In addition to practice variations in NMB monitoring, there are significant differences in the use of reversal agents at the end of a surgical procedure. Naguib M, et al. demonstrated in a survey that the respondents from Europe (82%) and the US (65.8%) reported that they did not routinely administer reversal agents [17]. Intraoperative management of neuromuscular blockade was similar between Chinese and European anesthesia providers. More than 95% of the respondents did not routinely use neuromuscular monitors. More than 70% of the respondents in this study did not administer reversal agents.

Remifentanyl is the most common opioid used for pediatric anesthesia in China. Remifentanyl is an ultra-short-acting narcotic that has a quick onset of action, can be titrated easily, and is metabolized promptly by esterase metabolism [18]. Remifentanyl has dose dependent synergistic anesthetic effects, therefore, the dose of other anesthetic agents can be decreased [19-21].

Other intraoperative adjuvants agents in pediatric anesthesia included anti-emesis medications. The incidence of postoperative vomiting and nausea (PONV) in children can be up to 89% in "high-risk" patients after surgery [22]. PONV can reduce quality of care, prolong hospital stay, cause unplanned admission, dissatisfy patients, parents, and healthcare providers [23]. Prevention of PONV is an important part of pediatric anesthesia care. Most of the respondents either routinely administered antiemesis medications for children under general anesthesia (37%), or provided antiemesis medications if the patient was at high risk of PONV (41%).

Standard intraoperative monitoring requirements for adult and pediatric patients are different in China. Recent anesthesia quality survey in China indicated that only 55% of the respondents routinely used end-tidal capnography (ETCO₂) for their patients who were undergoing general anesthesia [24]. In this survey, more than 85% of the respondents applied end-tidal capnography

in patients during general anesthesia. According to the guidelines from the Chinese Society of Anesthesiology, end-tidal capnography (ETCO₂) should be applied for pediatric patients [25], and is optional for most adult patients under general anesthesia [26].

Postoperative pain control is a key element in pediatric anesthesia. Most anesthesiologists used regional techniques as the choice of analgesia. In this survey, three regional techniques have been widely used: local infiltration, caudal, peripheral nerve block. Local infiltration is the most common technique for postoperative pain management in children. This simple, safe, low-cost technique is routinely used for postoperative analgesia. It is most commonly provided by surgeons. Caudal block is another commonly used in pediatric anesthesia, because caudal block is easily performed, and its complication rate is very low. Caudal blocks composed of almost 60% of all regional blocks in pediatric patients and were used in all age children [27]. Peripheral nerve blocks provide excellent intraoperative and postoperative analgesia in children [28]. Ultrasound guidance peripheral nerve blocks has been widely used. Evidence suggests that the use of ultrasound guidance offers higher success rate and longer duration of regional blockade in children [29].

A Sweden national survey on ambulatory surgery showed that intravenous induction was always used in 7-16 year-olds (85.7%), and frequently in 1-6 year-olds (49.3%) [30]. Our survey was consistent with Sweden's data. IV induction was more frequently used than inhalational induction in children 1-16 year old in China. However, our result also showed that IV induction was commonly used in infants in children's hospitals (including hospitals for women & babies). IV induction were used more frequently in children younger than 7-years-old in children's hospitals than in general hospitals. Healthcare providers may have better IV access skills in Children's hospital.

There are several limitations of the study. The survey study cannot confirm the exactness and reliability of the response. The survey instrument was not validated beyond the questionnaire. The survey was noncompulsory and unnamed, not intended to discover the characteristics of the responders. Therefore, respondent selection bias cannot be excluded. To optimize response rates, we randomly select some respondents with an award of free books. The reward can also cause selection bias. Recall bias cannot be excluded, because the answer for each question was recalled and estimated by the respondents.

Although most items were interesting, relevant, and well-constructed, some questions were still not specific and objective. For example, Q30,31 we asked about their extubation techniques (deep extubation or awake extubation) only in two age group (infants and preschool

age groups), because we limited the total questions in the survey. We should have asked these questions more specifically and included all age groups of children.

This survey is simply a portion of the current state of pediatric anesthesia in general in China. Other important information which is lacking in the study include pediatric anesthesia training, preoperative anesthesia evaluation, premedication drug choice, safety, recovery, outpatient surgery, postoperative care, and patient and parent satisfaction. These data are essential to help provide better care for individual patients and to the whole population. Therefore, more studies are needed in the future.

In conclusion, our survey showed a general picture of current pediatric anesthesia practice in general in China. This is the first pediatric anesthesia survey in China. The survey can serve as a foundation for forthcoming pediatric anesthesia studies. The results can help anesthesiologists to design pediatric anesthesia services and research projects.

Disclosure

- No ethical approval necessary.
- Conflict of interest.
- No funding for the research.
- All authors had no conflicts of interest.

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Editor: Yuan-Xiang Tao, Ph.D., M.D., Professor and Vice Chair, Director, Center for Pain Medicine Research Department of Anesthesiology, Editor in Chief, The Translational Perioperative and Pain Medicine, Rutgers, The State University of New Jersey, New Jersey Medical School, 185 S. Orange Ave., MSB, E-661 Newark, NJ 07103. Phone: 973-972-9812 (O) Email: yt211@njms.rutgers.edu

Additional publication details

Journal short name: Transl Perioper & Pain Med

Received Date: December 27, 2017

Accepted Date: January 24, 2018

Published Date: January 26, 2018

Citation: Zhu B, Gao H, Zhou X, Huang A, Huang J. Current Pediatric Anesthesia Practice in General in China: A National Survey. *Transl Perioper & Pain Med* 2018;5 (1):19-26.

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