

Current sedation practices for non-invasive procedures in tertiary maternity and children's hospitals in China: a 5-year update

Bo Li, Ruidong Zhang, Yanhui Huang, Lu Wang, Mazhong Zhang, Jijian Zheng 

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Department of Anesthesiology, Shanghai Children's Medical Center Affiliated to Shanghai Jiaotong University School of Medicine, Shanghai, Shanghai, China

Correspondence to

Dr Jijian Zheng;
zhengjijian626@sina.com

ABSTRACT

Background Sedation techniques can ease anxiety during medical procedures for children. Our previous report on Chinese sedation practices for non-invasive procedures in 2018 is outdated due to the rapid development of sedation services. This study provides an updated report on sedation practices for non-invasive procedures in China. **Methods** This is a cross-sectional study. Questionnaires were sent to tertiary maternity and children's hospitals nationwide through the WeChat Mini Program. The survey questioned the location and caseloads of hospitals providing sedation services, support facilities, contraindications, fasting practices, sedation regimens, monitoring practices, staff structure, certification requirements for sedation providers and quality control data.

Results Procedural sedation for non-invasive procedures were provided in 88 of 114 hospitals. These hospitals are located across the country except Heilongjiang province and the Tibet Autonomous Region. Compared with previous reports, significant increases were found in the number of hospitals providing sedation services, dedicated sedation rooms and recovery rooms and full-time sedation providers. Most hospitals advocated the 2-4-6 rule for pre-sedation fasting. Dexmedetomidine was the most used first-choice sedative. Anaesthesiologists remain the primary sedation providers, but nurses are also important. The most mentioned qualification requirements for sedation providers were a professional title of attending doctor, ≥5 years of working experience in paediatric anaesthesia and paediatric advanced life support certification. Sedation service records were used in 83 hospitals, but only 42 and 39 recorded success rates and adverse events, respectively.

Conclusions Sedation services for non-invasive procedures are available in most areas of China. More hospitals now provide sedation services and full-time sedation providers. Supporting facilities and sedation regimens have improved. Non-anaesthesiologist sedation providers are important at current stage, developing training programmes for them may be necessary. Attention should be focused on quality control and improvement of sedation services.

INTRODUCTION

Procedural sedation techniques have been widely used to reduce procedure-related anxiety and stress and to facilitate the

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Most tertiary maternity and children's hospitals provide sedation services for non-invasive procedures in China. However, sedation practices vary widely between hospitals.
- ⇒ Supporting facilities for sedation services is insufficient in China.
- ⇒ No training programme is available for sedation providers in China.

WHAT THIS STUDY ADDS

- ⇒ The number of hospitals that providing sedation services for non-invasive procedures and full-time sedation providers increase significantly in the past 5 years in China.
- ⇒ Supporting facilities and sedation regimens have improved.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ This study is valuable for understanding the existing problems and planning for the further development of sedation services in China.

implementation of medical procedures in the paediatric population. Since the first procedural sedation guideline was published by the American Academy of Pediatrics in 1985,¹ various guidelines have been updated periodically to direct sedation practices in different situations.²⁻⁴ Despite starting relatively late, procedural sedation services developed quickly in China since more and more paediatricians realised that anxiety and stress caused by medical procedures can result in psychological trauma and behavioural changes in the paediatric population,⁵ and they are working hard to promote the practice of procedural sedation. However, the current situation of procedural sedation in China is unknown.

In 2018, we released the first copy of the questionnaire on sedation practices for non-invasive procedures in China. We found that



the number of hospitals with full-time sedation providers was relatively low, and the supporting facilities for sedation services were also insufficient. Furthermore, sedation practices, including fasting criteria, sedation regimens and other-related aspects, differed dramatically among different hospitals and training programmes for sedation providers were absent.⁶ However, sedation services have received increasing attention in China; many hospitals are planning or have already initiated sedation services in the last 5 years. Our previous study no longer represents the current development of Chinese sedation practices. Therefore, this study aimed to provide an updated report on Chinese sedation practices for non-invasive procedures.

METHODS

This cross-sectional study used electronic questionnaires. We first searched for the registration information on the official website of the National Health Commission of the People's Republic of China for tertiary maternity and children's hospitals nationwide. Then, we communicated with the anaesthesia departments of these hospitals for their willingness to participate in this study. After obtaining oral informed consent from each hospital, we established a WeChat survey group and invited a representative from each hospital to join the group. The electronic questionnaire was released in the group in May 2023 and collected 1-month later. The survey questioned the location and caseloads of hospitals providing sedation services, support facilities, contraindications, fasting practices, sedation regimens, monitoring practices, staff structure, certification requirements for sedation providers and quality control data. All participants were asked to provide official statistical data on their hospitals whenever possible. Statistics were expressed as figures and proportions. The flow diagram of the study is shown in online supplemental figure 1.

Patient and public involvement

Patients and public were not involved in this study.

RESULTS

Based on registration information on the official website of the National Health Commission of the People's Republic of China, 133 hospitals were identified. 114 hospitals agreed to participate in this study, and all completed the questionnaires—the remaining 19 hospitals could not be contacted. At least one hospital from each province, autonomous region or municipality was included. The results showed that sedation services for non-invasive procedures were provided in 88 (77.2%) hospitals. Compared with 5 years ago, the number of hospitals providing sedation services increased by 30. However, due to the inclusion of more hospitals, the overall proportion of hospitals providing sedation

Table 1 The comparative analysis of the main findings from the 2018 and 2023 surveys

Survey items	2018	2023
Number of hospitals surveyed	63	114
Number and proportion of hospitals providing sedation services for non-invasive procedures	58 (92.1%)	88 (77.2%)
Number and proportion of hospitals with dedicated sedation rooms	14 (24.1%)	35 (39.8%)
Number and proportion of hospitals with dedicated recovery rooms	19 (32.8%)	39 (44.3%)
Number and proportion of hospitals with full-time sedation providers	15 (25.9%)	54 (61.4%)
*Most commonly used first-choice sedative	Chloral hydrate	Dexmedetomidine
*For details, please refer to online supplemental table 2.		

services decreased by 14.9%. The main findings of the two surveys were compared and presented in [table 1](#).

Geographical distribution and caseloads

Among the hospitals that provided sedation services for non-invasive procedures, 47 (53.4%) were in Eastern China, 3 (3.4%) in Northeastern China, 17 (19.3%) in Central China and 21 (23.9%) in Western China (online supplemental figure 2). Of these hospitals, 45 (51.1%) performed <1000 cases annually, 19 (21.6%) performed 1000–5000 cases annually, 5 (5.7%) performed 5000–10 000 cases annually and 16 (18.2%) performed >10 000 cases annually (see online supplemental table 1).

Supporting facilities

Dedicated sedation rooms (referring to areas dedicated to sedative administration and patient monitoring) were reported in 35 (39.8%) hospitals, 21 more than 5 years ago. Considering the geographical distribution, dedicated sedation rooms were available in 38.5%, 42.9% and 26.1% of hospitals in Eastern, Central and Western China, respectively. No dedicated sedation rooms were reported in Northeast China in this study. Furthermore, the proportion of hospitals with dedicated sedation rooms increased with an increase in annual caseloads—the proportions were 28.9%, 31.6%, 60% and 81.3% in hospitals with annual caseloads of <1000, 1000–5000, 5000–10 000 and >10 000, respectively.

Dedicated recovery rooms (referring to dedicated areas for post-sedation recovery) were reported in 39 (44.3%) hospitals, 20 more than 5 years ago. Considering the geographical distribution, dedicated recovery rooms were available in 46.2, 40.0%, 28.6% and 30.4% of hospitals in Eastern, Northeast, Central and Western China, respectively. Furthermore, the proportion of hospitals with dedicated recovery rooms was greater among

Table 2 Contraindications to sedation services for non-invasive procedures in tertiary maternity and children's hospitals in China

Contraindications	Number of hospitals (n=)	Proportion (%)
Diagnosed or suspected difficult airway	65	73.9
Respiratory tract infections	59	67.0
Fever	50	56.8
Untreated cardiovascular diseases	32	36.4
Liver or renal function dysfunction	24	27.3
Respiratory tract infection within 2 weeks	22	25.0
No definite contraindications	3	3.4
Not specified	8	9.1

hospitals with larger annual caseloads: 75% in hospitals with an annual caseload of >10 000 and approximately 40% in hospitals with an annual caseload of <10 000.

Other supporting facilities for sedation services, including oxygen supplies and monitoring devices, were installed in 81 (92.0%) hospitals. Crash carts (carts containing emergency medical equipment, supplies and medicines) and vacuum suction were installed in 80 (90.9%) and 78 (88.6%) hospitals, respectively.

Contraindications

The top three contraindications to sedation services for non-invasive procedures were diagnosed or suspected difficult airways, respiratory tract infections and fever. Additionally, untreated cardiovascular diseases, liver or renal dysfunction and respiratory tract infections within 2 weeks were mentioned. The details are listed in [table 2](#).

Fasting practices

In this study, most hospitals advocated the 2-4-6 rule for pre-sedation fasting; however, shortened fasting criteria were also applied in some hospitals. The details are listed in [table 3](#).

Sedation regimens

Compared with our previous findings, intranasal dexmedetomidine replaced oral chloral hydrate as the first-choice sedative in all age groups. A dosage of 1–2 µg/kg was most prevalent in children <1-year-old, while that of 2–3 µg/kg in children >1-year-old.

The most used rescue sedative was intranasal dexmedetomidine in children <1-year-old; the most prevalent dosage was 1–2 µg/kg. Propofol was the most widely used rescue sedative in children >1-year-old—the most prevalent doses were 1–2 mg/kg in children 1–4 years old and 0.5–1 mg/kg in children >4 years old.

The sedation regimen is detailed in online supplemental table 2.

Table 3 Pre-sedation fasting practices for non-invasive procedures in tertiary maternity and children's hospitals in China

	Fasting criteria (h)	Number of hospitals (n=)	Proportion (%)
Clear liquid	0.5	2	2.3
	1	5	5.7
	2	60	68.2
Breast milk	1	2	2.3
	2	14	15.9
	4	45	51.1
Formula milk	1	1	1.1
	2	4	4.5
	3	2	2.3
	4	16	18.2
	6	36	40.9
	8	21	23.9
Solid food	2	3	3.4
	4	9	10.2
	6	28	31.8
	8	21	23.9

Monitoring practices

Pulse oximeter was the most used device for patient monitoring. Except for 14 hospitals that did not specify monitoring requirements, pulse oximeter was used as the routine monitoring device in remaining 74 hospitals. ECG, non-invasive blood pressure and end-tidal carbon dioxide partial pressure were monitored in 35, 25 and 9 hospitals, respectively ([table 4](#)).

Staff structure

Similar to our previous report, anaesthesiologists are the primary sedation providers in China. Non-anaesthesiologist sedation providers included nurses, doctors in charge of patients (referring to the first doctor to see and care for the patient) and radiologists. Nurses were the most important sedation providers after anaesthesiologists. They were responsible for sedative administration and patient monitoring in approximately one-third of hospitals ([table 5](#)).

Among the 88 hospitals, 54 (61.4%) employed full-time sedation providers (referring to the medical personnel whose only duty was to care for the sedated children)—this number was 15 (25.9%) in our previous study. Both the number and proportion had increased significantly. Of these 54 hospitals, anaesthesiologists and nurses were employed as full-time sedation providers in 48 and 6 hospitals, respectively.

Certification requirements for sedation providers

The certification requirements for sedation providers vary widely among hospitals. Similar to our previous report, certification by paediatric advanced life support remains one of the most frequently mentioned requirements for

Table 4 Monitoring practices for sedation services in tertiary maternity and children's hospitals in China

Monitoring items	Number of hospitals (n=) Proportion (%)	
	Number of hospitals (n=)	Proportion (%)
Pulse oxygen saturation	74	84.1
ECG	35	39.8
Non-invasive blood pressure	25	28.4
End-tidal carbon dioxide partial pressure	9	10.2
Not specified	14	15.9

sedation providers. Other frequently mentioned certification requirements included the professional title of the attending doctor and ≥ 5 years of working experience in paediatric anaesthesia (see online supplemental table 3).

Quality control and improvement

Recording documents (referring to the paper or electronic documents that record patients' information, including demographic characteristics, pre-sedation complications, sedatives, vital signs and adverse events during the sedation process) were used in 83 (94.3%) hospitals. The overall sedation success rate and the incidence of sedation-related adverse events were recorded in 42 (47.7%) and 39 (44.3%) hospitals, respectively.

DISCUSSION

This paper provides an updated report on the development of current sedation practices for non-invasive procedures in China. Compared with our previous findings, we found that the number of hospitals providing sedation services and hospitals with full-time sedation providers increased significantly. The supporting facilities for sedation services also improved. Furthermore, dexmedetomidine replaced chloral hydrate as the most popular first-choice sedative in children of all age groups.

Compared with 5 years ago, a 14.9% decrease was noted in the proportion of hospitals providing sedation services. One reason for this finding might be that the National Health Commission of the People's Republic of China improved hospital information registration during the COVID-19 pandemic; therefore, more hospitals were registered on official websites. However, despite the decreased proportion, the number of hospitals

providing sedation services increased by 30. Further analysis indicated that the number of hospitals providing sedation services increased by 38.2%, 50%, 70% and 75% in Eastern, Northeastern, Central and Western China, respectively. The inland areas had a greater increase than the coastal areas, suggesting that significant efforts were made to promote and popularise sedation services in inland China.

The number of hospitals with dedicated sedation and recovery rooms increased significantly compared with 5 years ago. Our analysis found a definite trend that hospitals with greater annual sedation caseloads are more likely to establish dedicated areas for sedation services. In hospitals with annual caseloads >10000 , dedicated sedation rooms and recovery rooms were available in 81.3% and 75% of hospitals, respectively. Meanwhile, the proportion was much lower in hospitals with smaller annual caseloads. However, the overall proportion of hospitals with dedicated sedation and recovery rooms remains low nationwide, not exceeding 50% even in the economically developed eastern area. We believe that establishing dedicated areas specifically designed for providing sedation services will help in gathering children in one place for appropriate care. This is important because insufficient monitoring and inadequate recovery procedures can be risk factors for adverse events in sedated children.⁷ Recent guidelines recommend that dedicated rooms should be available for procedural sedation⁸ and that children should be monitored in appropriately staffed and equipped areas after sedation.³ Therefore, further improvements are required to supporting facilities for sedation services in China, especially in hospitals with smaller annual sedation caseloads.

Another apparent change observed in this study was that dexmedetomidine replaced chloral hydrate as the most used first-choice sedative. We think of this as an improvement in sedation regimens because chloral hydrate is associated with higher risks of desaturation and vomiting,⁹ and recent studies have indicated that dexmedetomidine is superior to chloral hydrate for successful sedation, onset time, recovery characteristics and incidence of adverse events.^{10–12} Although children sedated with dexmedetomidine show a greater incidence of bradycardia,^{13 14} it is commonly benign and easily managed by waking up the children.¹⁵ Therefore, dexmedetomidine can be considered as a suitable alternative to chloral hydrate in non-invasive paediatric procedures.¹⁶

Table 5 The staff structure of sedation services in tertiary maternity and children's hospitals in China

Sedation providers	Number of hospitals (n=)			
	Pre-sedation evaluation	Sedative administration	Patient monitoring	Patient discharge
Anaesthesiologists	72 (81.8%)	47 (53.4%)	45 (51.1%)	63 (71.6%)
Nurses	/	29 (33.0%)	27 (30.7%)	10 (11.4%)
Physicians in charge of the patients	3 (3.4%)	/	2 (2.3%)	3 (3.4%)
Radiologists	1 (1.1%)	2 (2.3%)	4 (4.5%)	2 (2.3%)
Not specified	12 (13.6%)	10 (11.4%)	10 (11.4%)	10 (11.4%)

Our results indicate that most hospitals participating in this study followed the 2-4-6 rule for pre-sedation fasting. However, we believe that fasting requirements in sedation practices can be less restrictive because no definitive relationship was observed between fasting duration and incidences of any adverse outcomes.¹⁷ Aspiration-related sedation mortality has been relatively low in the past decades. Only nine cases were reported in the literature from 1985 to 2016.¹⁸ At our institution, about 20 000–30 000 children need to be sedated for an echocardiography examination annually. They are asked to fast all kinds of foods in only 2 hours before sedation, and no aspiration is observed so far. The International Committee for the Advancement of Procedural Sedation (ICAPS) published a multidisciplinary consensus on pre-sedation fasting in 2020. In this consensus, patients were first evaluated and divided into three risk grades (negligible, mild or moderate aspiration risk); then, graded fasting criteria for different foods were recommended.¹⁹ The ICAPS-graded fasting criteria are more flexible than the traditional 2-4-6 rules and more adaptable to patients in different situations.

Some problems remain unaddressed in Chinese sedation practices. First, is it necessary to develop training programmes for non-anaesthesiologist sedation providers? As our results show, nurses are important in Chinese sedation practices at the current stage. However, to our knowledge, no training programme has been specially designed for them at present. Non-anaesthesiologist sedation providers may lack sufficient knowledge and skills including patient evaluation and monitoring, pharmacology of sedatives, adverse events management and life-supporting skills.²⁰ Due to the shortage of the anaesthesia workforce in China²¹ and the long training duration for qualified anaesthesiologists, non-anaesthesiologists are predicted to remain involved in sedation services for a long time in China. Although many studies have reported successful sedation being performed by non-anaesthesiologists,^{22–23} sedation services provided by non-anaesthesiologists may still be associated with a greater incidence of adverse events in high-risk populations.²⁴ Thus, it may be necessary to develop training programmes for non-anaesthesiologist sedation providers to improve the safety of sedation services in China.

Second, more efforts should be taken for the quality control and improvement of sedation services in China. Our results reveal an interesting question: recording documents for sedation services are used in >90% of hospitals; however, the overall sedation success rate and incidence of sedation-related adverse events are recorded in only <50% of these hospitals. One reason for this may be that procedural sedation has not been included in any of the official medical quality control and improvement programmes in China. Collecting and reviewing data regarding sedation safety will help analyse potential risks, optimise sedation practices and reduce the incidence of adverse events.^{25–26} Unfortunately, this work has not been

started in more than half of Chinese tertiary maternity and children's hospitals.

In general, paediatric sedation services for non-invasive procedures have developed rapidly over the past 5 years in China, as evident in the improved availability of services and supporting facilities. Compared with other countries, Chinese paediatric sedation practices have several distinctions, with the most notable being a significantly higher proportion of anaesthesiologists-provided sedation. Anaesthesiologists were responsible for pre-sedation evaluation, administration of sedatives, patient monitoring and patient discharge in 81.8%, 53.4%, 51.1% and 71.6% of hospitals in China, respectively (table 5). However, according to a series report from the Pediatric Sedation Research Consortium, only 10.3% of sedation cases in 2009 and 2.2% in 2017 were performed by anaesthesiologists.^{27–28} In another report from the The Korean Society of Anesthesiologists, it was found that only 12% of sedation cases were performed by anaesthesiologists.²⁹ One explanation for this difference could be the recommendation of the Chinese Experts' Consensus on Pediatric Anesthesia³⁰ Sedation Outside the Operating Room (2017 Edition), which emphasises that anaesthesiologists are responsible for providing sedation services.³⁰ In addition, the absence of training programmes for non-anaesthesiologist sedation providers in China hinders sharing the workload with anaesthesiologists, another possible contributing factor. The Chinese Experts' Consensus emphasises that non-anaesthesiologist sedation practitioners need 'sedation/anaesthesia training', but the specific 'training' components are not explicitly delineated. Compared with the relevant guidelines of other countries, the primary emphasis of the 'training' is predominantly on airway management and life support skills.^{3–4} Skills training cannot be performed on children because of ethical considerations. Fortunately, the recent development of simulation education in China has created favourable conditions for such training. To enhance the safety of paediatric sedation practices in China, we propose that simulation training in airway management and life support skills should be required for non-anaesthesiologists providing sedation.

Limitations

In this study, the respondents were restricted to tertiary maternity and children's hospitals in China. Although this study included most major and representative maternity and children's hospitals across the country, acknowledging that sample selection bias may arise from voluntary participation or familiarity with the study requirements is important. Furthermore, part of the data regarding paediatric procedural sedation could have been overlooked because children can also be sedated in general hospitals. Additionally, we invited only one anaesthesiologist from each hospital to participate to avoid repeated questionnaires. The answers provided by the anaesthesiologist may not be representative of the institution's sedation practices. Despite these limitations, we

believe our updated report of the current sedation practices for non-invasive procedures in China is valuable for understanding the existing problems and planning for the further development of sedation services in China.

CONCLUSIONS

Sedation services for non-invasive procedures have developed rapidly in recent years in China and covered most areas nationwide. Compared with the findings of our previous survey, this study found significant increases in the number of hospitals that provide sedation services and hospitals with full-time sedation providers, improvements in supporting facilities and remarkable changes in sedation regimens. Currently, non-anaesthesiologist sedation providers are still important in sedation practices; therefore, it may be necessary to develop training programmes for them. Furthermore, more efforts should be made to improve the quality control of sedation services in China.

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ORCID iD

Jijian Zheng <http://orcid.org/0000-0003-1903-9557>

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