Sedation for Pediatric Echocardiography: Evaluation of Preprocedure Fasting Guidelines

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In an effort to increase the safety of sedated procedures, there is a recent trend to increase preprocedure fasting times. However, optimal fasting times have never been established for a sedated echocardiogram. We retrospectively analyzed 334 patients divided into 2 groups. Group 1 (140 patients) had fasting times less than 2 hours, whereas group 2 (184 patients) had fasting times more than 2 hours. When the entire population was considered, there was no difference in efficacy between the 2 groups ($P = .08$). However, in patients younger than 6 months, group 2 had decreased efficacy compared with group 1 ($P = .03$). There were no major complications in either group. There was no difference in the rate of minor complications between the 2 groups. Our study concludes that longer fasting times are less efficacious in children younger than 6 months, and do not improve safety. (J Am Soc Echocardiogr 2002;15:980-3.)

Echocardiography has become the primary modality for evaluation and management of children with congenital and acquired heart disease.[1-5] Evolution of echocardiography has enabled pediatric cardiologists to become less dependent on invasive technologies such as cardiac catheterization. However, a detailed and accurate study requires a cooperative patient, a condition rarely achieved in children younger than 3 years. Thus, most pediatric centers use sedation when performing echocardiograms in this age group.

Previous work has demonstrated the safety and efficacy of sedation in children undergoing echocardiography.[6] However, optimal fasting times have not been established in the pediatric population. The report of the American Society of Anesthesiologist task force on sedation and analgesia by nonanesthesiologists states that there is insufficient data to test the hypothesis that preprocedure fasting results in a decreased incidence of adverse outcomes in patients undergoing sedation and analgesia (as distinct from patients undergoing general anesthesia).[7] Despite the lack of available information on optimal fasting times in the pediatric population, many hospitals have established uniformed policies requiring long fasting periods before sedation. In addition, longer fasting times can potentially result in higher complication rates, including inadequate studies (secondary to inadequate sedation), dehydration, and requirement for additional sedative medications. The purpose of this study was to determine whether prolonged fasting times decreased the efficacy of sedation or the incidence of adverse events in patients younger than 3 years who underwent a sedated echocardiogram.

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METHODS

We conducted a retrospective cohort study of all children undergoing sedation before an echocardiogram at Children's Medical Center of Dallas from 1997 to 1999. In general, all patients younger than 3 years who were referred for an echocardiogram were sedated. Rare exceptions included physician preference for unsedated study (ie, unstable clinical condition) or parental refusal. Nursing and physician assessment included weight, height, blood pressure, heart rate, and respiratory rate. A limited history and physical examination were performed before sedation. Patients were given choral hydrate, (80 mg/kg). Ten percent of patients were also given diphenhydramine (1 mg/kg) concomitantly, according to physician preference. Complete sets of vital signs were recorded every 10 minutes. Children were monitored for heart rate and arrhythmia with Tram transport monitors (Marquette Electronics, Milwaukee, Wis) before and after the echocardiogram. Patients were continuously monitored with pulse oximetry (Nellcor Inc, Hayward, Calif). Blood pressures were performed by Dinamap automated blood pressure cuffs (Critikon Inc, Tampa, Fla). If the patient was still asleep after completion of the echocardiogram, the nurse or parents stimulated the child. On awakening, the child was offered clear liquids as tolerated. Discharge criteria were appropriate for developmental age. In general, pa-

Table 1 Baseline group characteristics (all patients)

	Group 1 (n = 140)	Group 2 (n = 184)	*P* value
Fasting time (min)	80 (15-120)	255 (125-1200)	.01
Age (days)	206 (8-1287)	283 (0-1496)	.09
Weight (kg)	6.6 (2-15)	7.6 (2-19)	.13
Cyanotic heart disease	22 (16%)	15 (8%)	.32

Table 2 Baseline group characteristics (<6 mo)

	Group 1 (n = 67)	Group 2 (n = 71)	*P* value
Fasting time (min)	75 (15-120)	240 (125-945)	.01
Age (days)	72 (8-179)	83 (0-178)	.61
Weight (kg)	4.3 (2.3-9.4)	4.6 (2.6-8.2)	.13
Cyanotic heart disease	8 (12%)	7 (10%)	.69

tients were awake and responsive to commands, able to tolerate clear liquids, free of nausea, vomiting, and confirmed stable vital signs. Patients remained in the sedation room or echocardiography laboratory until discharged by a physician. A physician and complete set of resuscitation equipment, including oxygen and wall suction, were immediately available. Parents received postsedation instructions.

Inadequate sedation was defined as consciousness not adequately decreased within 30 minutes or awakening in less than 30 minutes. A major complication was defined as aspiration or an event that required hospitalization, transfer to a higher level of care, or an invasive procedure to stabilize the patient. Minor adverse events were defined as emesis, a change in oxygen saturation that required use of supplemental oxygen, arrhythmia, and a change in vital signs that required a noninvasive intervention as determined by the sedation nurse or responsible physician.

Statistical Analysis

Patients were divided into 2 groups. The group 1 fasted for less than 120 minutes before the procedure. Group 2 fasted for at least 120 minutes. A secondary analysis was performed with children younger than 6 months old. If a patient had more than 1 sedated echocardiogram, only the first examination was included in this study. Mann-Whitney *U* and chi-square analysis were used to compare baseline characteristics and rates of complications. A *P* value of $< .05$ was defined as significant. Statistical analysis was performed with SPSS-version 8.0 software (SPSS; Chicago, Ill).

RESULTS

Three hundred twenty-four consecutive patients underwent sedation in the echocardiography laboratory between 1997 to 1999. All procedures were performed without a major complication regardless of fasting times.

Table 1 identifies the baseline characteristics of the entire population. Forty-three percent of the patients had fasting times less than 120 minutes comprising group 1, whereas 57% had fasting times greater than 120 minutes making up group 2. The average fasting time for patients in group 1 was 80 minutes, compared with 225 minutes for patients in group 2. There were no significant differences in age, weight, or the presence of cyanotic heart disease. Forty-eight percent of the patients in group 1 were younger than 6 months compared with 39% in group 2. Table 2 examines the subgroup of patients younger than 6 months. Again, there were no differences in terms of age, weight, or the presence of cyanotic heart disease between the 2 groups.

The incidence of inadequate sedation was not different in the total population ($P = .08$), with 10 patients (5%) in group 1 and 23 patients (13%) in group 2 failing to achieve adequate sedation. However, there was a significant difference in the number of patients younger than 6 months who failed sedation ($P = .03$). Five patients (7%) belonging to group 1 compared with 14 patients (20%) belonging to group 2 were not adequately sedated.

There was a 9% rate of minor complications in both group 1 (12 patients) and group 2 (16 patients) ($P = .89$). Tables 3 and 4 document no significant difference in the complication rate of emesis, oxygen saturation, arrhythmia, adverse change in vital signs, or aspiration in either the total population or the subset of patients younger than 6 months.

DISCUSSION

The goals of sedation in children include guarding the patient's safety and welfare, minimizing physical discomfort or pain, controlling behavior, and returning the patient to a state in which discharge is safe. With these goals in mind and steered by national guidelines developed by the American Academy of Pediatrics, the American Society of Anesthesiologists, and Joint Commission on Accreditation of Health Care Organizations, many hospitals have developed new guidelines to reduce the risks associated with procedural sedation by nonanesthesiologists. These guidelines include preprocedure patient evaluation and preparation, preprocedure fasting times, monitoring, qualifications for personnel, availability of emergency equipment, and recovery care.[7] Because of the paucity of information available regarding the value of longer preprocedure fasting times, we designed a study to evaluate the effects of prolonged fasting times in children undergoing echocardiography at a large children's hospital.

Table 3 Adverse events (all patients)

	Group 1 (n = 140)	Group 2 (n = 184)	*P* value
All	12 (9%)	16 (9%)	.89
Emesis	8 (6%)	9 (5%)	.74
Oxygen desaturation	4 (3%)	6 (3%)	.55
Arrhythmia	0	1 (0.5%)	.57
Adverse change in vital signs	0	0	
Aspiration	0	0	

Table 4 Adverse events (<6 mo)

	Group 1 (n = 67)	Group 2 (n = 71)	*P* value
All	4 (6%)	9 (13%)	.18
Emesis	3 (5%)	5 (7%)	.74
Oxygen desaturation	1 (2%)	4 (6%)	.55
Arrhythmia	0	0	
Adverse change in vital signs	0	0	
Aspiration	0	0	

We were able to prove that shorter fasting times (<2 hours) were as safe as longer fasting times (>2 hours). However, there was a decrease in the efficacy of sedation in children younger than 6 months who had longer fasting times. One of every 5 patients younger than 6 months had inadequate sedation if they fasted more than 2 hours.

A properly sedated patient is essential for echocardiography because a complete examination is a time-consuming process that entails movement of a child into several positions to obtain optimal pictures in all the required views (subcostal, apical, parasternal, and suprasternal). At the same time, the sophisticated instrumentation of the echocardiography laboratory can be a frightening experience for a small child.[8] Inadequate sedation can cause missed or mistaken diagnosis, which can lead to catastrophic results. In addition, hemodynamic assessment of a child's heart condition will be altered in an uncooperative, inadequately sedated patient secondary to the change in heart rate and cardiac output. Doppler estimates of the pressure gradient in unsedated children averaged 41.5% (range 3%-275%) greater than pressure gradients measured in the same child sedated at cardiac catheterization.[9]

Several studies describe the safety of sedation. Adverse events occurred in 2.3% of 1180 emergency department patients (without minimum fasting times). All patients with adverse events had successful intervention by the emergency department personnel. No patients required reversal of sedation, endotracheal intubation, or hospital admission because of complications from sedation and analgesia.[10] In a review of sedation in children undergoing invasive and noninvasive procedures, adverse events were experienced in 20% of children. However, when these results are looked at more carefully, 63% of these "adverse" events were inadequate sedation. Of the remaining 37% of events, all were considered minor and resolved without long-term sequelae.[11] A review of 95 incidences of adverse sedation and analgesia events showed lack of monitoring, nonhospital-based venue, lack of assessment skills, and lack of appropriate intervention as the major determinants of adverse outcomes. Additional issues were inadequate presedation medical evaluation, lack of an independent observer, medication errors, and inadequate recovery.[12] These studies consistently document that under the appropriate conditions, sedation by a nonanesthesiologist is safe. Furthermore, there were no complications related to inadequate fasting times.

The practice of long fasting times before sedation in an attempt to prevent aspiration pneumonia has been controversial. Our study was inadequately powered to distinguish a difference in risk of aspiration between long and short fasting times because the incidence of aspiration in the pediatric population is rare.[13,14] However, we can use emesis as a surrogate for the risk of aspiration. We demonstrated no difference in the rate of vomiting between the short and long fasting times ($P = .74$). In addition, all episodes of emesis occurred at the time of the administration of medicines, when the patient was fully conscious, thus reducing risk of aspiration.

A prolonged fasting time theoretically decreases the risk of aspiration by providing low gastric volumes. However, studies in children undergoing general anesthesia have proven that despite a prolonged fast, children exhibit a large acidic residual gastric fluid volume at the time of induction.[15,16] Furthermore, prolonged fasting periods increased gastric acidity without significantly affecting the volume.[15] It is not possible to define the minimum volume that a patient must aspirate before manifesting sequelae of aspiration. Thus, the custom of declaring patients at risk of developing aspiration pneumonia on the basis, all or in part, of their residual gastric volume is suspect.[17]

Study Limitations

There are several important limitations to this study. First, the retrospective nature of this study did not allow us to control for the exact fasting time. Although this is clearly a scientific liability, it much more accurately reflects the everyday activity of an echocardiographic laboratory. For example, it is common for a parent not to awaken an infant 2 hours before the echocardiogram to offer the child clear liquids, thus the fasting time can greatly exceed the 2-hour period. In addition, patients were not randomized. The majority of patients in group 1

had echocardiograms performed before the initiation of a new hospital policy to increase fasting times. Several ill children who had echocardiograms after the new policy had fasting times less than 2 hours because physicians were worried about complications related to prolonged fasting times. For example, many physicians would shorten fasting times in children with uncorrected tetralogy of Fallot to decrease the risk of a hypercyanotic event. This risk stratification should only strengthen our results because group 1 patients would then tend to be at a subjectively higher risk. In addition, both a physician and a nurse specially trained in sedation protocols evaluated each patient before sedation. If a patient was thought to have a viral illness, significant airway problems, or appeared critically ill, the plan for sedation was abandoned and no sedation record was kept. Although we believe this policy contributed to the lack of a significant adverse event occurring during this study, it should have affected both groups equally.

It is important to note that this study was performed at a large children's hospital in the confines of the echocardiography laboratory. All patients had a limited history and physical examination performed by a nurse and physician before undergoing sedation. Patients had extensive monitoring before, during, and after the echocardiogram. By the nature of the test, we had continuous visualization of the heart and electrocardiogram. Complete resuscitation personnel and equipment were immediately available. Therefore, the applicability of this study to sedation in other environments is not clear.

CONCLUSION

The issue of appropriate fasting times for children undergoing sedation by nonanesthesiologist for procedures has been debated for many years. Unfortunately, most policies have relied on grouping all sedation practices in all environments (ie, radiology, emergency department, and echocardiography laboratory) into one policy. In this study, we have shown that longer fasting times decrease efficacy of the sedation without improving safety. This study demonstrates that echocardiograms can be performed safely in the proper setting with shorter fasting times. It is important that all future sedation policies consider the unique aspects of each procedure, the environment the sedation is performed in, and the consequences of an incomplete or substandard test.

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