

# A comparison of conventional versus electronic monitoring of sedated pediatric dental patients

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## Abstract

*The first purpose of this study was to compare traditional monitoring methods to electronic instruments for monitoring physiologic parameters during conscious sedation of pediatric dental patients. Traditional methods included careful visual assessment of skin color, airway patency and chest movements, and auscultation of breath and heart sounds using a precordial stethoscope; electronic instruments included the capnograph and pulse oximeter. The second purpose of the study was to examine the potential of the capnograph to provide more advanced warning than the pulse oximeter for respiratory compromise.*

*Thirty-nine children (mean age 39 months) received an oral sedative regimen of chloral hydrate, hydroxyzine pamoate, and meperidine and all were supplemented with 100% oxygen via nasal cannula throughout their sedations. One investigator used traditional monitoring and the other used electronic — both monitored simultaneously while being shielded (blinded) from each other.*

*Electronic monitoring yielded a false alert rate of 88% compared with 73% for traditional monitoring. Ten confirmed episodes of respiratory compromise were identified electronically and only three were identified by traditional monitoring. All of the 10 confirmed respiratory compromise episodes were detected by capnography; none were detected by oximetry. During these 39 pediatric sedations using a narcotic drug regimen and 100% oxygen supplementation, there were no true desaturations. (*Pediatr Dent* 17:332–39, 1995)*

**T**raditional methods of physiologic monitoring of consciously sedated pediatric patients include visual observation of tissue color, measurement of pulse and respiratory rates and use of a precordial stethoscope for auscultation of heart and breath sounds.<sup>1</sup> For electronic monitoring, the pulse oximeter provides noninvasive monitoring of arterial oxyhemoglobin saturation ( $SpO_2$ ), pulse rate and pulse strength; the capnograph provides noninvasive, quantitative monitoring of respired carbon dioxide ( $CO_2$ ) tension

and respiratory rate. Pulse oximetry has become a common addition to the monitoring armamentarium for pediatric dental sedation and is required by the 1992 guidelines developed by the American Academy of Pediatrics to meet the standard of care for the monitoring of sedated pediatric patients.<sup>2–11, 12</sup> Capnography, however, has had little attention as a monitor for sedated pediatric dental patients.<sup>6, 13</sup>

The global purpose of this study was to compare information derived from traditional monitoring of sedated pediatric dental patients with information derived from the pulse oximeter and the capnograph.

## Literature review

### Traditional monitoring methods

The time-honored methods of monitoring sedated patients include visual assessment of chest movements and tissue color, measurement of pulse and respiration rates, and auscultation of heart and breath sounds with a precordial stethoscope. Each of these methods has been shown to have major shortcomings.<sup>4, 14–18</sup> Visual observation of the rise and fall of the chest is an important monitoring procedure, but reveals only respiratory effort, not necessarily gas exchange.<sup>16</sup> During pediatric dental sedations, visual observation of tissue color can be obscured by dental paraphernalia, such as the rubber dam, patient eye protection, and patient restraints. Furthermore, relying on these clinical signs and symptoms to recognize hypoxemia is unsafe because changes occur late in relation to oxygen saturation<sup>14</sup> and can be affected by hemoglobin concentration, tissue pigmentation, ambient light, and the observer's skill in distinguishing color changes.<sup>19</sup>

The precordial stethoscope provides a simple and inexpensive extension of the anesthesiologist's senses,<sup>20</sup> but the design of the instrument (i.e. variation in size of the stethoscope, type and length of tubing) can give varying and unreliable results.<sup>17</sup> The only accurate information obtainable from the precordial stethoscope is the presence and characteristics of heart and breath sounds.<sup>17</sup> Furthermore, auscultatory assessment can be

difficult for the practitioner because of noise in the operatory, such as crying or whining, handpiece sounds, high-speed evacuation, and dental team communication.<sup>4</sup> Finally, the precordial stethoscope offers unreliable information regarding ventilation adequacy.

### **Pulse oximetry**

Early studies of electronic monitors in the pediatric sedation environment demonstrated that the pulse oximeter detected incidents of peripheral oxygen desaturations during sedations that did not correspond to irregularities of other physiologic parameters like blood pressure and pulse rate.<sup>2,21,22</sup> This confirmed that electronic monitors had the potential to detect mild hypoxemic episodes undetected by traditional means. Since 1985, at least 18 other studies have examined physiologic monitoring in the pediatric dental sedation arena.<sup>5,6,9,10,18,23-36</sup> These studies touted pulse oximetry as the gold standard for monitors because of its ability to detect hypoxemia early in the course of a respiratory compromise in a sedated child.

Although its value has been demonstrated repeatedly, pulse oximetry is not without limitations. Artifacts or errors in pulse oximetry output can be introduced by hypothermia, altered hemoglobin status, poor tissue perfusion, crying, and patient movement.<sup>10</sup> Pulse oximetry provides a spectrophotometric analysis of hemoglobin (i.e., the redness of the blood) and in most cases, provides an accurate and reliable measure of the oxyhemoglobin saturation in the central arterial blood;<sup>29,37</sup> however, pulse oximetry will not detect anemic, toxic, or ischemic hypoxia because the redness of the blood is not altered in these conditions.<sup>9</sup>

Although the accuracy of the pulse oximeter has been reported to be relatively acceptable in the SpO<sub>2</sub> range of 70–100%, readings below this range can be drastically inaccurate due to the shape of the oxyhemoglobin dissociation curve and inherent instrument limitations.<sup>7,9,38</sup> Also, while pulse oximetry gives an accurate reflection of respiratory status, it is not a real-time monitor of respiratory parameters. For example, in a child with an undetected airway occlusion, the pulse oximeter may not reveal a change for a minute or more, at a point where the partial pressure of arterial oxygen (PaO<sub>2</sub>) has dropped precipitously. Furthermore, small changes in arterial oxyhemoglobin saturation (SaO<sub>2</sub>) signal large changes in PaO<sub>2</sub>; accordingly, those who utilize pulse oximetry must understand the oxyhemoglobin dissociation curve and the basic mechanisms underlying pulse oximetry and its function as a respiratory monitor.

### **Capnography**

Capnography is a technology that relies on monitoring expired concentrations of CO<sub>2</sub> using infrared spectrophotometry. Through a nasal cannula, expired air is sampled and analyzed for CO<sub>2</sub> by infrared absorption. This technology has proven to be a valid and reliable method of monitoring respiratory compromise.<sup>4,5,9,18,39-41</sup>

Capnography is used easily for children asleep under general anesthesia, but this technology has practical limitations for consciously sedated children including nasal cannula displacement during head movement and cannula obstruction with nasal secretions.<sup>39,41,42</sup> Mouth breathing also may reduce the accurate detection of expired air.<sup>42</sup> However, a major advantage of capnography is its potential to detect an airway compromise before it can lead to a change in hemoglobin saturation.<sup>6,10,40</sup>

Few studies have examined the use of capnography for sedated pediatric dental patients. Iwasaki et al.<sup>6</sup> demonstrated that the capnograph detected airway obstruction prior to pulse oximeter detection and found a trend in decreased respirations approximately 30 sec prior to a desaturation event. However, under the conditions of Iwasaki's study, the capnograph's early warning did not provide a practical advantage over the pulse oximeter.

### **Oxygen supplementation**

Anesthesiologists suggest oxygen supplementation as one method to improve the safety of conscious sedation.<sup>5,43,44</sup> In the supplemented patient, there is an extra margin of safety against hypoxemia because the PaO<sub>2</sub> can be elevated to as high as 600 mm Hg. Due to the relationship of PaO<sub>2</sub> to SaO<sub>2</sub> on the oxyhemoglobin dissociation curve, however, the pulse oximeter does not reveal downward trends in PaO<sub>2</sub> at levels greater than 100 mm Hg. Thus, in the hyperoxic child, the PaO<sub>2</sub> may need to fall drastically before any change will be detected in the SaO<sub>2</sub>.<sup>5,9</sup> For this reason, in children supplemented with 100% O<sub>2</sub>, the capnograph may provide an earlier warning of respiratory problems than the pulse oximeter. To date, this question has not been studied.

### **Current standard of care for monitoring sedated pediatric patients**

Conscious sedation is defined as a minimally depressed level of consciousness wherein a patient retains the ability to maintain a patent airway. Deep sedation is defined as a controlled state of depressed consciousness or unconsciousness wherein the patient may lose the ability to maintain a patent airway. In the conventional dental office setting, conscious sedation is the desired level of CNS depression; however, even under conscious sedation, pediatric patients are at risk for respiratory compromise from a drug-induced respiratory depression or airway obstruction, which can lead to hypoxemia.<sup>13,35,36,45-49</sup>

To promote greater safety in the sedation of pediatric dental patients, in 1985 the *Guidelines for the Elective Use of Conscious Sedation, Deep Sedation, and General Anesthesia in Pediatric Patients* specified, at a minimum, the use of a precordial stethoscope for continuous monitoring of heart rate and respiratory rate, and periodic evaluation of tissue color, nailbed color, and mucosa color.<sup>1</sup> In 1992, these guidelines were revised and specified for conscious sedation that heart rate, respiratory

rate, blood pressure, and oxygen saturation (SpO<sub>2</sub>) be monitored continuously and that monitoring equipment should include, at a minimum, a pulse oximeter.<sup>12</sup>

The guidelines define a standard of care for monitoring sedated pediatric patients, and although nearly 20 studies have been undertaken in the pediatric dental environment confirming pulse oximetry's validity, convenience, and practicality, it is clear that this technology has been embraced slowly. Surveys suggest that the use of the pulse oximeter during pediatric sedations ranges from 0 to 69%.<sup>50-52</sup>

In spite of a plethora of information on traditional monitoring and electronic monitoring, no systematic comparisons have been reported. Thus, the first objective of this study was to compare systematically three methods of monitoring physiologic parameters of children consciously sedated for dental treatment: 1) traditional monitoring using visual observation, measurement of heart and respiratory rates, and use of the precordial stethoscope for auscultation of heart and breath sounds; 2) pulse oximetry; and 3) capnography.

Our second objective was to examine the added potential of the capnograph to provide a more advanced warning than the pulse oximeter for ventilatory changes in consciously sedated pediatric patients receiving supplemental 100% O<sub>2</sub>.

## Methods and materials

### Sample

The initial sample consisted of 44 pediatric conscious sedation patients that fulfilled specific criteria. All 1) met Class I ASA anesthesia risk assessment, 2) were 24-48 months old, 3) were referred to the departmental sedation clinic because of unmanageable behavior in the conventional dental environment, and 4) had restorative dental procedures lasting at least 30 min from time of local anesthetic injection.

### Methods

Children were referred to the Pediatric Sedation Clinic (PSC) at the University of North Carolina at Chapel Hill School of Dentistry where a preliminary screening examination was completed to determine whether conscious sedation was an appropriate treatment option. The PSC's routine protocol requires: 1) a presedation physical from the child's physician, 2) informed consent from the legal guardian for conscious sedation and all needed dental care, and 3) written pre- and postoperative sedation instructions with a parent's or guardian's signature confirming their comprehension of these instructions. Specific informed consent also was obtained for each child's participation in this study.

All patients received the standard PSC oral sedation regimen of 50 mg/kg chloral hydrate (Pharmaceutical Basics Inc, Morton Grove, IL), 25 mg hydroxyzine pamoate (Vistaril®, Pfizer Laboratories, New York, NY), and 1.5 mg/kg meperidine (Demerol®, Winthrop-Breon, New York, NY). No patient received nitrous oxide/oxygen analgesia.

After receiving sedation medications, the patient and parent/guardian waited in a quiet, comfortable preop sedation room. Forty-five to 60 min after receiving medications, the child was taken to the dental operatory, placed in a Papoose Board® (Olympic Medical Group, Seattle, WA), and monitoring probes were attached. To deliver oxygen and collect expired CO<sub>2</sub>, a nasal cannula (No. 4706F, Salter Labs, Arvin, CA) for capnography monitoring was placed in the child's nares. The pulse oximeter probe Oxisensor II® (Nellcor Inc, Hayward, CA) was placed either on the first or second toe of the left foot. Due to possible variations in pulse oximeter readings caused by skin temperature changes, a temperature probe (Hi-Lo Temp Skin®, Mallinckrodt Medical Inc, Raleigh, NC), using the Mon-a-therm® temperature monitor (Mallinckrodt Medical Inc, Raleigh, NC), was placed on the dorsum of the left foot next to the toes. Both feet were covered with a towel to reduce ambient light. A precordial stethoscope was placed to the left of the sternum for auscultation of breath and heart sounds.

For this study, the Nellcor-1000® (Nellcor Inc, Hayward, CA) electronic monitor was used. This instrument is a combination pulse oximeter-capnograph that can be connected to a printer to print trend data.

Consistent with the PSC protocol for conscious sedations of children 24-48 months old, all received 100% O<sub>2</sub> supplementation, starting immediately upon their being seated in the dental chair. The large tubing connector of the cannula system was attached to an oxygen outlet and O<sub>2</sub> was delivered at a flow rate of 3 L/min through the same cannula used for CO<sub>2</sub> sampling.

All patients were monitored simultaneously by two investigators experienced in physiologic monitoring of sedated children. The investigators were shielded (blinded) from one other, but each had an unobstructed view of the patient and dentist/operator. Heart rate (HR) and respiratory rate (RR) were recorded on separate standard monitoring records by both investigators and synchronized for recording at 5-min intervals. At any time during treatment, either investigator could alert the operator when respiratory compromise was suspected and necessary adjustments (i.e., patient head position or cannula adjustment) would be made by the operator. Each investigator recorded their alerts on their respective monitoring record. The audio alarms were silenced to blind Investigator A from the electronic monitors' audio signals.

Investigator A monitored by continuous visual assessment, auscultation with a precordial stethoscope, and palpation for chest movement. Investigator B recorded data from the Nellcor-1000 monitor, from which hard copy printouts were generated at the conclusion of each case. Investigator B monitored the electronic panels continuously, recording patient behavior and the procedure events simultaneously. With each occurrence of a desaturation or apneic episode, Investigator B used the time-based hard copy printout to make spe-

cific notes about events occurring at the time (injection, rubber dam placement, crown placement, etc.) and patient movement. Axial foot temperatures were recorded every 5 min. To assess the effectiveness of the standard monitoring techniques, Investigator B alerted the operator of suspected respiratory compromise when the pulse oximeter read less than 90% SpO<sub>2</sub> for longer than 30 sec or when the capnograph showed apnea of longer than 15 sec.

At the conclusion of the sedation appointment, consistent with our PSC protocol, the operator and both investigators arrived at a consensus on the sedation outcome. Each case received a rating of either excellent, satisfactory, unsatisfactory, or aborted (Table 1) according to established criteria to which both investigators and operators were calibrated.

### Data analysis

To compare systematically the methods of monitoring physiologic parameters of children consciously sedated for dental treatment, the data recorded on the anesthesia records for investigators A and B were compared with the number of investigator alerts to the operator during the sedation. Episodes of true respiratory compromise were defined as abnormal capnograph readings >15 sec during times of sleep or quiet behavior. Hard data printouts for the pulse oximeter and capnograph were compared also to determine whether trends could be found in capnography that could provide an earlier warning signal than was detected with pulse oximetry. The study design and sample size dictated that we rely upon descriptive rather than statistical data analysis.

### Results

Forty-four patients (mean age, 39 months; range 24–48 months) were enrolled in the study. Five (11%) sedation cases were aborted due to uncooperative behavior, so data were collected from 39 patients only. Of the 39 completed sedation cases, 13 (30%) were rated

as excellent sedations, 16 (36%) as satisfactory, and 10 (23%) as unsatisfactory. Because patient behavior often affects monitoring, results were analyzed by behavioral category.

### Traditional versus electronic monitoring

Comparison of the number of alerts for respiratory compromise to the operator by Investigator A versus Investigator B is shown in Table 2. Investigator A gave 11 alerts, of which three were confirmed as respiratory compromise or true positives. Eight of the 11 alerts were associated with normal capnograph readings and were considered artifacts or false positives associated with a displaced precordial stethoscope, or with unusual airway sounds without obstruction. The overall false positive rate was 73% for Investigator A.

Relying upon the electronic monitors, Investigator B gave 85 alerts. Ten were confirmed as true respiratory compromise. Seventy-five were false positives, all occurring during times of poor patient behavior, operator or patient interference, or mechanical obstruction of the sampling ports. The overall false positive rate was 88% for Investigator B.

For comparisons by behavior category, Investigator A had the lowest overall false positive rate and the lowest rate of 33% for the satisfactory behavior category (Table 2). For all other categories, results for both investigators were nearly identical. However, Investigator B detected seven episodes of clinically confirmed respiratory compromise that were not detected by Investigator A. In summary, the electronic monitors had a higher overall false positive rate but detected more true positive (10 versus three episodes).

### Pulse oximetry versus capnography

Data from pulse oximetry revealed a total of 16 readings of SpO<sub>2</sub> < 90% in nine patients. As illustrated in Table 3, all abnormal readings were attributed to patient movement, monitor displacement, or a low extremity temperature. One patient experienced an 8° drop in foot temperature from 95 to 87°F, but for

**TABLE 1. SEDATION OUTCOME RATINGS**

<i>Excellent</i>	Treatment completed without difficulty, minimal crying and patient quiet and/or asleep for most of case
<i>Satisfactory</i>	Treatment completed with minimal difficulty, but alternating periods of crying and struggling with periods of quiet and/or sleep
<i>Unsatisfactory</i>	Treatment completed with difficulty due to crying and struggling throughout treatment
<i>Aborted</i>	Treatment not completed due to combative behavior that increased the risk of injury to the patient or the dental team

**TABLE 2. ALERTS TO OPERATOR**

<i>Sedation Rating</i>	<i>Total</i>	<i>True</i>	<i>%</i>	<i>False</i>	<i>%</i>
<i>Investigator A</i>					
Unsatisfactory	2	0	0	2	100
Satisfactory	3	2	67	1	33
Excellent	6	1	17	5	83
Overall	11	3	27	8	73
<i>Investigator B</i>					
Unsatisfactory	25	0	0	25	100
Satisfactory	43	7	16	36	84
Excellent	17	3	18	14	82
Overall	85	10	12	75	88

all other patients values remained constant with fluctuations of no more than 5° (range 87–98°F).

An abnormal capnographic reading was defined as a period of no nasal breathing for a period longer than 15 sec. Data analysis revealed 85 abnormal capnographic readings in 31 patients. As illustrated in Table 4, 65 abnormal readings (76%) occurred during periods of poor patient behavior during crying and mouth breathing. Ten abnormal readings (12%) occurred with operator or patient interference of the nasal cannula. Ten abnormal readings (12%) occurred when the patients were quiet or asleep and were confirmed clinically as true episodes of respiratory compromise with no evidence of airway exchange. In each case, normal respiratory pattern was established with correction of head position. Recovery time from a confirmed respiratory compromise was on average 33 sec (range 15–72 sec). There were no desaturations during any of these cases of true respiratory compromise.

## Discussion

### The need to monitor

Morbidity and mortality statistics from sedations and general anesthesia cases in dental offices reveal that most misadventures in the dental environment result from shortcomings in patient management, specifically the underuse of monitoring and resuscitative efforts.<sup>53, 54</sup> In a review of mishaps in the dental office, Krippaehne<sup>53</sup> reported that 62% of the patients were monitored by visual observation only, and routine physiologic monitoring was uncommon. Several studies have surveyed the monitoring methods used specifically for pediatric conscious sedations. Findings suggest that practitioners recognize the need to monitor pediatric patients cautiously, but most don't use the most effective monitoring methods in their daily practice.<sup>50–52, 55, 56</sup>

The 1985 *Sedation Guidelines*<sup>1</sup> were the first established standards of care for the pediatric sedation arena. Recent surveys<sup>50–52, 55, 56</sup> reveal disappointing compliance with these guidelines in daily practice. As one example, a 1992 survey of physicians who sedated children for diagnostic procedures revealed that most were unaware of the guidelines and only 18% thought they applied to their procedures.<sup>52</sup>

### Factors limiting usefulness of monitoring methods

We found that traditional monitoring methods are comparable to electronic monitoring when patients are

TABLE 3. ABNORMAL PULSE OXIMETER READINGS

Variable	Incidence	%
Monitor displacement	8	50
Struggling	4	25
Low foot temperature	4	25
Total	16	100

TABLE 4. ABNORMAL CAPNOGRAPH READINGS

Variable	Incidence	%
Poor patient behavior (crying, mouth breathing)	65	76
Operator/patient interference (cannula displacement)	10	12
Patient asleep	10	12
Total	85	100

well-sedated, but precordial stethoscope monitoring is affected strongly by crying and room noise. In particular, respiratory rate is difficult to assess with a precordial stethoscope because of crying or room noise, forcing reliance upon visual observation and/or palpation of chest movement.

Relative to false alerts, the traditional monitoring methods may have more discrimination during the unsatisfactory and satisfactory sedations but less sensitivity during those cases when the patient is well-sedated (Table 2). Our results show that traditional monitoring methods missed episodes of true respiratory compromise that the electronic monitoring detected.

Concurring with the findings of Anderson et al.<sup>5</sup> and Iwasaki et al.,<sup>6</sup> we found that electronic monitors became more valuable with increasing depths of sedation. As have other investigators,<sup>7, 57–61</sup> we found that often the pulse oximeter gives false readings secondary to motion artifact during struggling, muscle tension of the extremity, monitor displacement, low extremity temperature, ambient light, and incorrect probe placement. Like Pan et al.,<sup>62</sup> we found that most pulse oximeter false alarms are due to motion.

The accuracy of capnography can be affected by crying, struggling, nasal congestion, and mouth breathing, all of which can be identified incorrectly as an apparent apneic episode. With capnography we experienced an overall false positive rate of 88% for warnings. Despite its false positives, the capnograph was the best method to detect airway compromise, especially during periods of greater depths of sedation, sleep, or quiet.

It seems clear that the clinical adjustments made for abnormal capnographic readings almost certainly prevented potential desaturations from occurring. It is impossible to know from our study design whether the pulse oximeter, if given more time, would have detected a respiratory compromise. Based on these results, the capnograph provided, at a minimum, a 15-sec advance warning for a potential desaturation. Under the conditions of this study, it was not possible to determine if these episodes would have been self-limiting or would have gone on to cause physiologic harm to the patient if not corrected.

We found that patient behavior influenced the effectiveness of the different monitoring methods. For the child who is sedated well from the appointment's start to finish, all monitoring methods can be equally effective. However, we have found that the sedated children's behavior was quite variable, sometimes

changing minute-to-minute within the same appointment. These results show that all monitoring methods give false positive warnings, but for the child who is well-sedated, capnography proved to be more effective in detecting a true respiratory compromise.

Capnography is an excellent method for detecting decreased respiratory rate or apnea, but it does not provide quantitative assessment of minute ventilation. Therefore, it should be used as an adjunct to traditional monitoring methods. Even though we detected no true desaturations, the pulse oximeter provides confirmation that a patient's respiratory efforts are providing adequate blood oxygenation.

#### **Pediatric sedations with supplemental oxygen**

Evidence is overwhelming that hypoxemia is the major risk factor in pediatric sedation.<sup>5,45</sup> In healthy, sedated pediatric patients, hypoxemia can result from 1) a drug-induced respiratory depression from a decreased rate or depth of respiration or 2) airway obstruction due to loss of protective reflexes secondary to the sedative drug effect.

Children have a high basal oxygen consumption and their smaller size provides less oxygen reserve. Because of the risk of hypoxemia during conscious sedation, O<sub>2</sub> supplementation has been recommended to provide an O<sub>2</sub> reserve to give an extra measure of protection for sedated patients.<sup>43,44,63</sup> Because supplemental O<sub>2</sub> increases pulmonary O<sub>2</sub> reserve capacity, desaturation of hemoglobin is delayed during periods of hypoventilation. In a normally ventilating patient receiving supplemental O<sub>2</sub>, the PaO<sub>2</sub> may increase from 90 to 100 mm Hg on room air to as high as 600 mm Hg, depending upon the actual inspired O<sub>2</sub> concentration. Due to the increased pulmonary O<sub>2</sub> reserve and subsequent increased arterial O<sub>2</sub> content, patients gain protection during periods of hypoventilation. Because of the nonlinear shape of the oxyhemoglobin dissociation curve, decreasing levels of arterial O<sub>2</sub> content will not be detected by the pulse oximeter until hemoglobin saturation begins to change to a PaO<sub>2</sub> of < 100 mm Hg.

It should be noted that if a child hypoventilates during O<sub>2</sub> supplementation, it is possible that arterial CO<sub>2</sub> can rise. A significant rise could lead to respiratory acidosis. While the relative risk of respiratory acidosis is less than that of hypoxemia, it should be noted that O<sub>2</sub> supplementation can mask hypoventilation and hypercarbia. We concur with Phero<sup>42</sup> that the capnograph provides an extra measure of safety because it monitors for hypoventilation and hypercarbia, but the absence of a capnograph should not dissuade the practitioner from utilizing O<sub>2</sub> supplementation in healthy sedated children.

We found that capnography gives immediate detection of airway compromise prior to any potential desaturation events, supporting findings by Anderson et al.<sup>5</sup> and Iwasaki et al.<sup>6</sup> In contrast to our patients, Iwasaki's were not supplemented with O<sub>2</sub> but

desaturations were reported in that study on children of similar ages as those in our study.

In our study using an oral narcotic regimen and 100% O<sub>2</sub> supplementation via nasal cannula, no true desaturations were found in 39 conscious sedations. A study by Roberts et al. reported no desaturations in 42 narcotic sedations in children supplemented with nitrous and oxygen analgesia.<sup>64</sup> Taken together, these studies suggest when sedated children are supplemented with O<sub>2</sub> and when airway compromise is detected quickly and corrected, there is little chance of desaturation episodes as detected by pulse oximetry. We would caution, however, that our study examined supplementation via 100% O<sub>2</sub>, not via nitrous oxide and oxygen analgesia. Others have suggested that the sedative effects of nitrous oxide may counter balance the effects of the O<sub>2</sub> supplementation in nitrous oxide and oxygen analgesia,<sup>58</sup> so this question needs further study.

#### **Conclusions**

Under the conditions of this investigation:

1. Electronic monitoring identified 10 episodes of confirmed respiratory compromise, of which only three were identified using traditional monitoring. Therefore, for maximum patient safety, electronic monitoring should be used in addition to traditional methods to monitor sedated pediatric dental patients.
2. Traditional monitoring had a false positive rate of 73 versus 88% for electronic monitoring; however, the overall clinical impact of providing a more sensitive method of detecting potentially harmful episodes of respiratory compromise far outweighs any relative inconvenience caused by false positives.
3. There were 10 confirmed episodes of respiratory compromise detected by capnography and none of the 10 were detected by pulse oximetry.
4. No true desaturations occurred during 39 sedations using an oral narcotic drug regimen and 100% O<sub>2</sub> supplementation.

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## Newly Elected Officers of the American Board



**Elizabeth S. Barr**

Dr. Elizabeth S. Barr, Westminster, Colorado, was recently elected Chair of the American Board of Pediatric Dentistry after serving as a Director of the Board since 1989. Dr. Barr received her dental degree and specialty training in pediatric dentistry from the University of Kentucky College of Dentistry, and she is a Fellow of the American College of Dentists.

Dr. Barr has served on the American Academy of Pediatric Dentistry's Public Information Committee, and she has been active in the Annual Meeting Program by presenting mini-clinics, research papers, and panel discussions. She is a Past President of the Colorado Unit of the American Society of Dentistry for Children.

Dr. Paul O. Walker, Associate Dean for Clinical Affairs at Baylor College of Dentistry, was elected to the position of Director of the American Board of Pediatric Dentistry during the Annual Meeting of the American Academy of Pediatric Dentistry in San Fran-



**Paul O. Walker**

cisco, California. Dr. Walker also is a Professor in the Department of Pediatric Dentistry at Baylor College of Dentistry and a Diplomate of the American Board of Pediatric Dentistry. He is an active member of the following professional organizations; the American Academy of Pediatric Dentistry, American Association of Dental Schools, Texas Academy of Pediatric Dentistry, American Dental Association, Texas Dental Association, and Dallas County Dental Society. In addition, Dr. Walker is on the staff of Texas Scottish Rite Hospital, Children's Medical Center of Dallas, and Baylor University Medical Center. Dr. Walker received a DDS from Northwestern University and an MS from Indiana University. He was a member of the faculty at the University of Minnesota from 1972 until 1994. Dr. Walker and his wife, Jill Stoltenberg, have residences in both Dallas, Texas, and Shoreview, Minnesota.