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Changes in Oxygen Saturation Following General Anesthesia in Children with Upper Respiratory Infection Signs and Symptoms Undergoing Otolaryngological Procedures

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Anesthesiologists frequently face the problem of a child with signs and symptoms of an acute upper respiratory infection (URI) presenting for surgery. The risk of anesthesia and surgery in these patients has not been clearly established. A previous study at our hospital has shown that patients with a history of resolving URI have an increased risk of developing perioperative atelectasis and hypoxia,[1] yet others[2–4] have suggested that anesthesia and surgery in the presence of an uncomplicated URI may have minimal morbidity and may not be contraindicated.

In this study, we prospectively examined the possible association between URI symptoms and systemic arterial oxygen saturation before and following general anesthesia in otherwise healthy children presenting for elective otolaryngological surgery.

MATERIALS AND METHODS

The study was approved by the institutional research committee and parental consent was obtained. Fifty children ranging in age from 1 to 4 yr were studied: 25 without history or signs and symptoms of URI (controls), and 25 with signs and symptoms of URI during

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the week preceding or at the time of surgery. The criteria used for diagnosis of upper respiratory infection are shown in table 1.

All children were scheduled to have ENT procedures; namely, bilateral myringotomies and tubes (BMTs), tonsillectomies and adenoidectomies (T & As), or simple adenoidectomies (Ad). The decision to proceed with surgery in the presence of URI signs and symptoms was made by the attending anesthesiologist assigned to the case, who was not one of the investigators, based on the frequency of symptoms, clinical evaluation, and the overall assessment of the potential risk and benefit to the child in each case. Radiological examination of the chest was performed to confirm clinical findings in two patients; both were normal. Preoperative oxygen saturation was measured before the induction of anesthesia while the patient was breathing room air, using a pulse oximeter. Preoperative medication was not used. All patients were anesthetized with nitrous oxide and halothane, and all, except those undergoing BMTs, had their tracheas intubated. No muscle relaxants and no analgesic drugs were administered intraoperatively. No supplemental oxygen was administered during transport from the operating room. Immediately upon arrival in the post-anesthesia recovery room (PARR), measurement of oxygen saturation was performed. If the oxygen saturation fell below 95% in the PARR, oxygen (10 l/m) was administered. Oxygen saturation measurements were repeated at 5-min intervals in the recovery room until patients met the Aldrete discharge criteria,[5] and then for 30 min in a short stay recovery unit (SSRU). The Aldrete scoring system[5] grades patient's activity, respiration, circulation, consciousness, and color with a point system from zero to two, with two being the accepted maximum score for each variable. A total score of nine or ten satisfies discharge criteria.

Oxygen therapy was continued as needed until the patients were able to maintain a $SaO_2 \geq 95\%$ while breathing room air. Patients who underwent adenoidectomies and/or BMTs were treated on an ambulatory basis, while those who had T & A were admitted overnight. All ambulatory patients received a phone call 24 h after surgery, and all in-patients were visited prior to discharge from the hospital to inquire about possible postoperative complications. The level of oxygen saturation while breathing room air in patients with signs and symptoms of URI was compared to that of controls using the Fisher's exact test, with $P < .05$ considered statistically significant in all cases.

TABLE 1. Signs and Symptoms of Upper Respiratory Infection (URI)*

1. Mild sore throat
2. Sneezing
3. Rhinorrhea
4. Congestion
5. Mild malaise
6. Non-productive cough
7. Fever 37.5–38° C
8. Laryngitis
9. WBC ≥ 10,000 cells/mm³

* Children were entered in the study if they had a combination of at least two of these symptoms. However, combinations of 2 and 3, 1 and 5, 6 and 4, 5 and 9, 6 and 9, or 7 and 9 required one additional symptom to make the diagnosis of URI. The number of patients who presented with a combination of two, three, or more than three symptoms was 13, 11, and one, respectively. Two children had a combination of symptoms 3 and 4, while none had the combinations 3 and 5 or 5 and 7.

RESULTS

Patients in the study and control groups were comparable in age, sex, duration of anesthesia, and type of surgical procedure (table 2). All children in both study and control groups had oxygen saturations above 95% before induction of anesthesia. There were no incidents of intraoperative cyanosis or laryngeal spasm in either group. There was no difference in the degree of wakefulness as measured by the admission scores to the recovery room.

Although no patients in the control group had oxygen saturation below 95%, five patients (20%) with URI signs and symptoms had oxygen saturations below 95% while breathing room air in the recovery room (table 3). This difference between the two groups is statistically significant ($P < 0.03$). Two of those five patients had BMTs without endotracheal intubation, while three had adenoidectomies with an endotracheal tube in place. When oxygen was administered to these five patients with low oxygen saturation, SaO_2 returned to normal in all cases and remained above 95% until they

TABLE 2. Patients' Age (yr), Duration of Anesthesia, and Number of Patients Undergoing Different Types of Surgery in the Two Groups

	URI Symptoms (n = 25)	Control (n = 25)
Age (yr)		
Mean	2.56	2.68
SD	1.12	1.14
Range	1–4	1–4
Duration of anesthesia (min)		
Mean	52	53
SD	30	22
Range	15–120	15–90
Type of surgery		
T & A	7	11
T & A + BMT	6	3
Ad + BMT	5	5
BMT	7	6

T & A = tonsillectomy and adenoidectomy; BMT = bilateral myringotomy and tubes; URI = upper respiratory infection.

TABLE 3. Number of Patients Who had $SaO_2 < 95\%$ while Breathing Room Air in the Recovery Room

	Control (n = 25)	URI Group (n = 25)
$SaO_2 \geq 95$	25	20
$SaO_2 < 95$	0	5

$P < 0.03$. URI = upper respiratory infection.

met discharge criteria. When oxygen therapy was discontinued just prior to discharge from PARR, SaO_2 was above 95% in all five patients. Oxygen saturation remained above 95% while breathing room air for at least 30 min in the SSRU. The postoperative course was unremarkable in all patients, and there was no clinical evidence of any respiratory complications in the hospital. None experienced hoarseness of voice, persistent cough, or other possible sequelae of tracheal intubation. No patient had any clinical findings that required follow-up chest radiographs. The telephone follow-up call revealed no cases of new or exacerbated signs or symptoms related to the respiratory system. No patients had to be re-admitted to the hospital.

DISCUSSION

The presence of an upper respiratory infection is one of the most common medical reasons for cancellation of elective surgery in the pediatric population. McGill *et al.*[1] reported that intraoperative and postoperative pulmonary dysfunction may be observed in the child with an URI presenting for surgery. Intraoperatively, there is increased susceptibility to coughing and laryngospasm due to the irritation of the airway by copious secretions. Inspissated secretions also may lead to atelectasis with a wide alveolar-arterial oxygen gradient and possible hypoxemia. They concluded that a specific history of URI within 1 month of surgery should be sought, a thorough physical examination performed, and a preoperative chest radiograph taken whenever the resolution of the URI is in doubt before proceeding with elective surgery.

One of the problems that has plagued anesthesiologists for a long time is the definition of the term "URI." Children with URI signs and symptoms do not always have an acute infectious process. The "URI" signs and symptoms may be the result of a non-infectious condition, such as allergic or vasomotor rhinitis.[6] In the absence of universally accepted absolute criteria for the diagnosis of respiratory infection, it is evident that an overlap of the diagnostic criteria for allergic rhinitis and a true URI is unavoidable (*e.g.*, patients with combination of symptoms 3 and 4 or 3 and 5 in table 1). We, therefore, studied children with "URI signs and symptoms" and avoided making a specific differentiation of infection *versus* allergy. These children often present for "semi-elective" otolaryngological surgical procedures in an attempt to control the source of their repeated and frequent symptoms. The practice of automatically cancelling surgery in this group of children results in repeated trips to the hospital, and, frequently, no change in symptoms. Many anesthesiologists are now willing to anesthetize patients with these signs and symptoms, and some have reported no increase in perioperative complications over those with no such findings.[2-4] Although one must be prepared to face the consequences of anesthetizing a child with a reactive airway, such as cough, breath holding, and laryngeal spasm, a recent study suggested that the majority of complications were associated with endotracheal intubation.[3]

Mild hypoxemia, however, may be present in patients with URI signs and symptoms. Hypoxemia may not be detected clinically in the operating room, and may be first observed in the recovery room after supplemental oxygen has been discontinued. Our study shows that patients with symptoms or a history of an URI during the week prior to surgery may have decreased oxygen saturation in the recovery room to levels requiring supplemental oxygen. However, since oxygen saturations were not routinely monitored intraoperatively in our patients, one cannot rule out the possibility that desaturation may have been initiated during surgery or during transport from the operating room to the PARR. Although Glazener *et al.*[7] recently reported a number of otherwise healthy children who became hypoxemic in the recovery room after general anesthesia, our study showed postoperative decrease in oxygen saturation in some children with URI signs and symptoms, but not in healthy controls. The finding that our study patients had normal oxygen saturation prior to being anesthetized, and manifested transient desaturation early in the recovery period, may be related to the inability to manage secretions following general anesthesia. These patients are probably able to clear their airways and prevent hypoxemia while breathing room air only when their ventilatory function is not depressed by the effects of anesthetic agents.

In conclusion, we found that children ages 1–4 yr with URI signs and symptoms at the time of surgery or a history of URI in the previous week are at increased risk of developing transient postoperative hypoxemia. Preoperative oxygen saturation measurements are not predictive of possible postoperative hypoxemia in these children. The decision as to whether or not to proceed with surgery in these children should be only undertaken after careful evaluation of such factors as the nature and urgency of the proposed surgical procedure and the severity and frequency of the URI. Those who must be anesthetized should be given supplemental oxygen and have their oxygen saturation monitored in the recovery room and during transport.

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Pulse Oximeter Desaturation Due to Methemoglobinemia

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Pulse oximetry is widely used to provide a continuous estimate of arterial oxygen saturation (SpO_2). Pulse oximeters are inferential monitors. They measure the light absorbance of perfused tissues at two wavelengths (660 and 940 nm) and, from the ratio of the pulse-added absorbance signals at these two wavelengths, use an algorithm to estimate arterial oxygen saturation.[1,2] Erroneous SpO_2 readings have been reported with the use of dyes[3,4] and in the presence of carboxyhemoglobin.[2] A case is reported in which a low SpO_2 reading alerted us to the presence of unsuspected methemoglobinemia.

REPORT OF A CASE

A 20-yr-old woman was scheduled to undergo a total proctocolectomy. Six years prior to this admission, she had bloody diarrhea and abdominal pains and was diagnosed as having ulcerative colitis. She was treated with prednisone and asulfadine. Subsequently, she developed pyoderma of her left hand, which was treated by surgical drainage under uneventful general anesthesia 2 yr prior to this admission. Two months prior to admission, she developed pyoderma gangrenosum of the anterior tibial region bilaterally, and therapy with dapsone was begun. There was nothing else of note in her past medical history. At the time of admission, her medications included only prednisone 20 mg b.i.d. and dapsone 150 mg q.i.d.; the latter drug was discontinued upon admission. On physical examination, the patient was in no apparent distress, was obese (72.72 kg, 160 cm), and had pyoderma of both shins. Arterial blood pressure was 128/70 mmHg, heart rate 100 bpm and regular, and respiratory rate noted as 22 breaths/minute. Physical examination was otherwise unremarkable, and, in particular, there was no evidence of cyanosis. Preoperative laboratory values were within normal limits (hemoglobin 10.9 g/dl, hematocrit 31.7%, blood CO_2 26 mEq/l). Chest radiograph was reported as normal.

On the third day of hospitalization, the patient was premedicated with morphine sulfate, 10 mg im and hydrocortisone, 100 mg iv. Upon arrival to the OR, monitoring was with an EKG, automated blood pressure monitoring device (Dinamap™), and a finger sensor connected to an Ohmeda Biox 3700 pulse oximeter (Ohmeda, Boulder, CO). With the patient awake, supine on the operating table, and breathing room air, the pulse oximeter read an SpO_2 of 89%. The sensor was checked and placed on a finger of the opposite hand, but the SpO_2 reading remained 89-90%. The sensor was placed on the author's finger, and the SpO_2 increased to 97%. The sensor was replaced on the patient's finger, and she was given 100% O_2 to breathe from the anesthesia circle system *via* a facemask. The pulse oximeter reading increased to, and remained steady at, an SpO_2 of 92-93%. Analysis of arterial blood gases with a F_{IO_2} of 1.0 showed pH_a 7.50, Pa_{CO_2} 29 mmHg, Pa_{O_2} 587 mmHg, calculated saturation (by nomogram) 99.9%, oxyhemoglobin percentage of total hemoglobin (%HbO_2) by an IL 282 laboratory co-oximeter (Instrumentation Laboratory, Lexington, MA) 92.8%, hemoglobin 10.5 g/dl, and hematocrit 34%. A second arterial sample was analyzed for the presence of dyshemoglobins. Methemoglobin was detected at a percentage concentration of 5%, and carboxyhemoglobin 2.0%, of total hemoglobin. Anesthesia was induced with thiamylal sodium 300 mg iv, and paralysis was provided by succinylcholine 100 mg iv followed by iv increments of vecuronium. Anesthesia was maintained with N_2O/O_2 (4l/2l), isoflurane, and fentanyl. The anesthetic and surgical courses were uneventful. The trachea was extubated at the end of the procedure and the patient was transferred to the recovery room. While breathing an F_{IO_2} of 0.4 from a face mask, SpO_2 read 94%, pH_a was 7.40, Pa_{CO_2} 33 mmHg, Pa_{O_2} 139 mmHg, base excess −1.9 mEq/l calculated saturation 98.9%, measured %HbO_2 (by IL 282) 93.4%, methemoglobin 2.9%, and carboxyhemoglobin 0.3%. A blood sample sent for hemoglobin electrophoresis showed a normal pattern. The patient made an uneventful recovery from her surgery and was discharged home 2 weeks later.

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