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Assessing Pediatric Anesthesia Practices for Volunteer Medical Services Abroad

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Background: **Anesthetic techniques and problems in volunteer medical services abroad are different from those of either the developed countries from which volunteers originate or the host country in which they serve because of differences in patient population, facilities, and goals for elective surgery. Assessing outcomes is hampered by the transience of medical teams and the global dispersion of providers. We studied general anesthesia techniques and outcomes in a large international voluntary surgical program.**

Methods: **Anesthesia providers and nurses participating in care of patients undergoing reconstructive plastic and orthopedic surgery by Operation Smile over an 18-month period were asked to complete a quality assurance data record for each case. Incomplete data were supplemented by reviewing the original patient records.**

Results: **General anesthesia was used in 87.1% of the 6,037 cases reviewed. The median age was 5 yr (25th–75th percentiles: 2–9 yr). Orofacial clefts accounted for more than 80% of procedures. Halothane mask induction was performed in 85.6% of patients; 96.3% of patients had tracheal intubation, which was facilitated with a muscle relaxant in 19.3%. Respiratory complications occurred during anesthesia in 5.0% of patients and during recovery (postanesthesia care unit) in 3.3%. Arrhythmias requiring therapy occurred in 1.5%, including three patients to whom cardiopulmonary resuscitation was administered. Prolonged ventilatory support was required in seven patients. There was one death. Inadvertent extubation during surgery occurred in 38 patients. Cancellation of surgery after induction of anesthesia occurred in 25 patients. Overall, complications were more common in younger children.**

Conclusions: **Our study showed that in this setting it is feasible to track anesthesia practice patterns and adverse perioperative events. We identified issues for further examination.**

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MEDICAL specialists from developed countries frequently travel to underdeveloped parts of the world to provide medical care or education or to help establish new services. Surgical programs may offer elective treatment of congenital and acquired conditions that are life limiting (*e.g.*, congenital heart disease), interfere with livelihood or daily activities (*e.g.*, orthopedic deformities, cleft palate, burn contractures) or are socially stigmatizing (*e.g.*, cleft lip, urogenital abnormalities).

The following is a description of one setting in which a voluntary program might take place: A 400-bed regional government hospital serves a district of a half million inhabitants in which the lifetime risk of dying during childbirth exceeds 2%.** The hospital's three small operating rooms are furnished with equipment 30–50 yr old and electricity that functions several hours per day. Medical staff may not include an anesthesiologist. Throughout the hospital, equipment and supplies are scarce; latex gloves, urinary catheters, and endotracheal tubes are washed and reused. Bed sheets are available for few patients, for whom the burden of caring for them depends on family members. Children are anesthetized for newborn emergencies, trauma, and a few urgent procedures, but elective reconstructive surgery is not accessible. Practices are not based on outcomes review. Because of the high demand relative to sparse resources, acceptable risk for anesthesia may be perceived quite differently than in practices in more developed countries.

Voluntary programs that provide free elective surgery attempt to adapt modern practices and standards to the host environment, using various mixes of local and shipped equipment. We considered that the practice of anesthesia in these mobile groups might involve unique issues and proposed to begin systematic evaluation of perioperative care. We are not aware of any group that has a regular prospective quality assurance mechanism

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** World Health Organization Statistical Information System (WHOSIS Query Service): http://www.who.int/whosis/maternal/mortality/revmm.pdf. Accessed June 30, 2001.

for voluntary international surgical activity. A recent survey†† identified more than 150 U.S.-based programs that send volunteer medical professionals to underdeveloped countries to provide training or service. Because volunteer groups do not consist of permanent staff and temporary teams are distributed worldwide, monitoring anesthesia practices and problems poses particular challenges.

The purposes of the current study were to develop a profile of anesthetic practices and to evaluate how to develop a quality assurance mechanism for one worldwide voluntary surgical program based in the United States, Operation Smile (Norfolk, VA).

Operation Smile is an international charitable organization that provides training for professionals and free reconstructive surgical services to children in underdeveloped countries. Most procedures are for correction of cleft lip and palate, but operations for orthopedic deformities, burn contractures, and urogenital malformations are also performed. The multinational teams are recruited from the United States and the participating host countries. Each team consists of five to seven anesthesia providers (anesthesiologists and nurse anesthetists); five to seven surgeons; and nurses, medical records librarians, dentists, speech therapists, and other specialists according to the needs of the site. In-country professionals are encouraged to work along with the team; some in-country physicians later become team participants for other sites. Thus, a typical team may consist of professionals from four to eight different countries, most of whom received their training in their own country. Since 1982, it is estimated that Operation Smile has provided surgery to 32,000 patients and had training contacts with more than 1,000 health professionals.‡‡

Materials and Methods

Study Design

A cohort analysis of anesthesia cases performed by Operation Smile was completed over the course of 18 months (February 1998 to August 1999). A group of nine anesthesia providers familiar with Operation Smile activities developed the Perioperative Events Log, a one-page form that incorporates elements of quality assurance for intraoperative and postanesthesia care unit (PACU) events with a brief description of anesthetic techniques (Web Enhancement). For every patient undergoing surgery, the anesthesia provider and PACU nurse were requested to complete the form. To enhance compliance, they were not asked to sign the forms. All forms were returned to the Norfolk, Virginia, headquarters of Operation Smile. Four classes of data were recorded: demographics, anesthesia techniques, selected adverse anesthesia events, and selected PACU events.

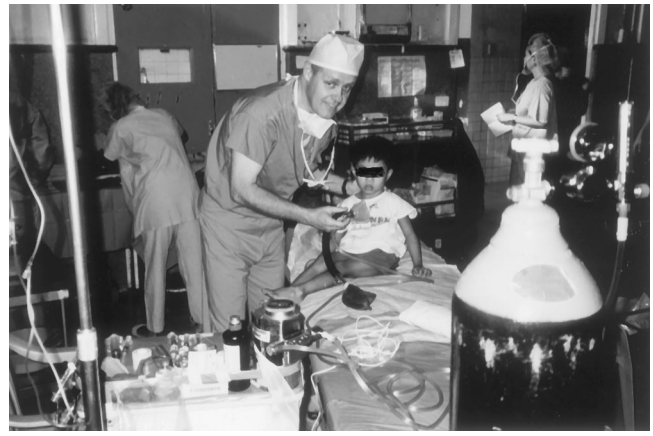

Fig. 1. Typical anesthesia work station. Dr. Scott Oldroyd, negotiating with a young patient at the Corazon Locsin Montelibano Memorial Regional Hospital in Bacolod, Negros Occidental, Philippines. The anesthetizing apparatus consists of a nonrebreathing system attached to a halothane vaporizer. Oxygen to the vaporizer passes through a regulator mounted on an oxygen H cylinder. There is no flush valve. During the study period, monitors typically consisted of precordial stethoscope, pulse oximeter, and manual blood pressure measurement. Electrocardiograms were usually unavailable. If needed, a defibrillator could be used as an electrocardiographic monitor. Dr. Oldroyd is a staff anesthesiologist at Lakeview Hospital, Bountiful, Utah.

Anesthetic Management

During the period of our study, available routine monitoring included auscultation, manual blood pressure, and pulse oximetry (fig. 1). Capnography and electrocardiography were infrequently available. Anesthetic management was entirely at the discretion of the individual anesthesia provider; no attempt was made to standardize therapy. Mechanical ventilators were not routinely used for intubated patients. Premedications were rarely used. Patients were monitored in the PACU with pulse, blood pressure, respirations, hemoglobin saturation, and temperature measurements. They were discharged from the PACU when deemed fit (fully awake, acceptable vital signs, clear airway, and calm). Operation Smile practice does not mandate a minimum length of stay.

Definitions

Adverse events were defined as follows. In the operating room, laryngospasm was an airway obstructive event requiring positive pressure ventilation and administration of succinylcholine with or without emergency intubation. Bronchospasm was the development of wheezing with or without hemoglobin desaturation requiring treatment with an inhaled bronchodilator (β-agonist) in the operating room or PACU. Upper airway obstruction was a postoperative airway obstruction requiring jaw thrust or placement of a nasal or oral airway

†† Committee for International Education and Service, Society for Pediatric Anesthesia, Richmond, Virginia: http://www.pedsanesthesia.org. Accessed August 10, 2001.

‡‡ Operation Smile Annual Report. Norfolk, Operation Smile, Inc., 1999.

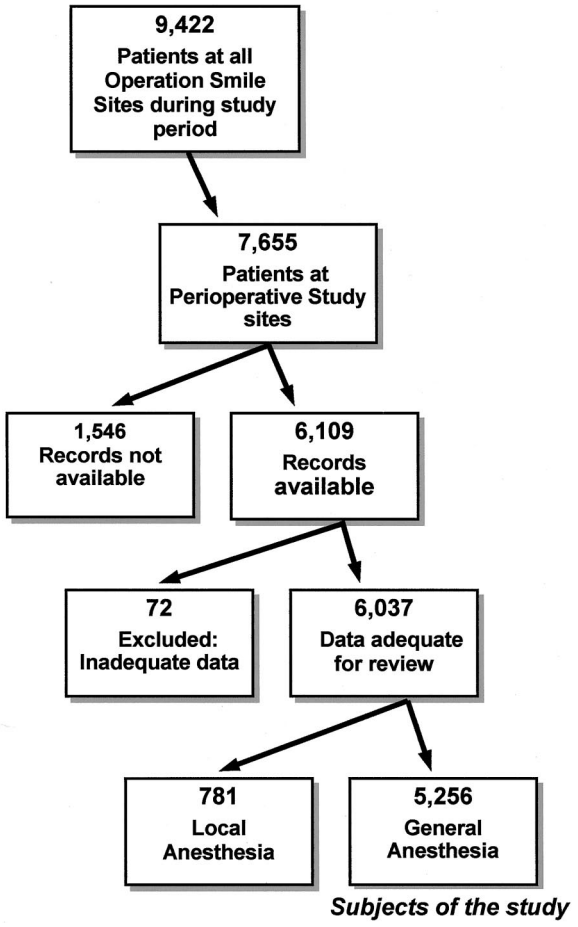

Fig. 2. Study population.

to regain patency. Croup was the postoperative development of hoarseness or stridor requiring treatment with racemic epinephrine or steroids. Arrhythmias were recorded if the anesthesia provider noted any one of the following: bradycardia associated with hypotension or requiring treatment with a vasoactive drug, supraventricular tachycardia, premature ventricular contractions and bigeminy in repeated episodes or sustained for more than a few beats, and ventricular tachycardia. Except for bradycardia, electrocardiographic monitoring was required for documentation of arrhythmias. If time in the PACU was more than 1 h, the reason was noted and recorded as a delay due either to a specified complication or to logistical and convenience factors. Significant negative events were defined as occurrences that resulted in patient morbidity beyond ordinary expectations for the operation (*e.g.*, injury, prolonged hospitalization) or posed a realistic risk to patient safety.

Inclusion and Exclusion Criteria

Sites were included for review if the Perioperative Events logs arrived on site and were returned to Operation Smile headquarters. As each form was reviewed, the original patient chart was also reviewed by a trained assistant to complete missing items or resolve ambiguities. Patient data were excluded from the study if the anesthesia chart record was unavailable or if the following data elements were missing: type of operation, type of anesthetic (general *vs.* local), surgical status (first operation or return to the operating room), or age.

Data Analysis

For purposes of analysis, patients were stratified into six age categories: less than 2 yr, 2–4 yr, 5–9 yr, 10–14 yr, 15–19 yr, and 20 yr or older. Surgical status was assigned in one of two categories: elective first operation for that mission or urgent return to the operating room. Outcomes were analyzed separately for first-time operations so that no patient would be tabulated twice. Data were stored in Microsoft Excel (Microsoft Corporation, Redmond, WA) in Baltimore, Maryland. Tabulations and analyses were performed using SPSS 10.0 (SPSS, Chicago, IL). Chi-square tests were used to assess the relation of age to occurrence of complications.

Results

During the 18-month study period Operation Smile teams operated on a total of 9,422 patients during 69 sites visits in 18 countries. The Perioperative Events Log was provided to 57 sites serving 7,655 patients (fig. 2). Logs and original anesthesia records were available for 6,109 patients in 51 sites. Among those, 6,037 patients (98.8%) had sufficient information to allow analysis. General anesthesia was used in 5,256 (87.1%), and local anesthesia in 781 cases (12.9%). The current study concerns the subgroup of patients who had general anesthesia for their procedures.

The median age of general anesthesia patients (fig. 3) was 5 yr (25th–75th percentiles: 2–9 yr), with a range of 3 months–63 yr. Most surgery was for repair of cleft lip and palate deformities; other frequent operations were

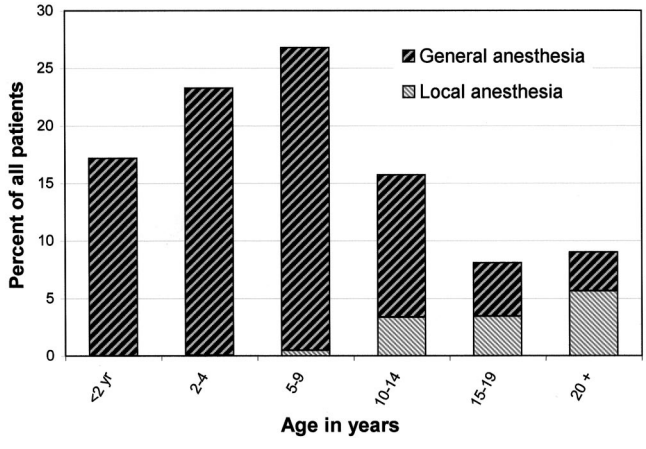

Fig. 3. Age distribution of study population (6,037 patients).

Table 1. Primary Surgical Procedures Among 6,037 Patients

Procedure	No. of Patients*	
	General Anesthesia	Local Anesthesia
Cleft lip repair or revision	2,393	512
Cleft palate repair	1,839	2
Pharyngoplasty/pharyngeal flap	137	0
Frenuloplasty	30	3
Dental extraction only	8	7
Burn contracture release ± skin graft	378	70
Excision of skin lesion	148	163
Eyelid procedure	44	7
Otoplasty	27	9
Osteotomy of hip or long bones	46	0
Tendon release/lengthening	43	0
Club foot correction	11	0
Syndactyly/polydactyly correction	71	1
Urologic procedure	20	0
Cancellation after anesthesia induced	26	0
Other surgical procedures	35	6
Totals	5,256	781

* Only the primary procedure is listed. Many patients had more than one procedure, *e.g.*, 143 patients who had palate repair also had lip surgery.

release of scar contractures, excision of skin lesions, and orthopedic procedures (table 1).

Anesthesia Techniques

Anesthesia was induced by halothane inhalation in 4,495 (85.6%) patients. Endotracheal intubation was the chosen method for airway management in 4,971 (96.3%) of the 5,161 patients for whom airway management was documented. All patients had intravenous access secured. In 509 (10.6%) of the intubated patients, this was performed after tracheal intubation. Muscle relaxants were used for tracheal intubation in 959 cases (19.3%) (succinylcholine in 11.8% and non-depolarizers in 7.5%). Of note, the combination of halothane and intravenous succinylcholine was used in 355 intubated patients (7.1%); a third of those who were given this combination were under 2 yr of age. Other intravenous adjuvants such as lidocaine or propofol were used to facilitate intubation in 952 cases (19.2%). Opioids were given in the operating room or the PACU to 1,267 patients (24.1%).

Complications

In the operating room, airway complications were the most frequent difficulty. Laryngospasm, bronchospasm, and endotracheal tube difficulties occurred in a total of 5.0% of general anesthesia cases (fig. 4). Children under age 5 yr had a relative risk of airway complications 3.4 times that of those age 5 yr or older (95% confidence interval: 2.6–4.6; $P < 0.05$). Episodes of laryngospasm were frequently associated with laryngoscopy and intubation, but a few occurred after extubation as well; only two episodes were in non-intubated patients. There were 38 cases (0.8%) in which the endotracheal tube was inadvertently removed during the surgical preparation or procedure; all but 3 of these patients were under 5 yr of age. Among the cases of dislodgement, half were in palate or pharyngeal flap cases, and the other half in lip surgery cases. Nine children (0.2%) required reintubation because of obstruction or kinking.

In the PACU, 175 patients (3.3%) had one or more documented airway difficulties. These consisted of upper airways obstruction in 48 (0.9 %), croup in 79 (1.5%), or bronchospasm in 58 (1.1%) (fig. 5). Delayed transfer from the PACU to the ward was attributed to excess sedation in 114 (2.2%), pain or agitation in 92 (1.8%), or excess bleeding in 89 cases (1.7%).

Cardiovascular complications were reported in 77 cases (1.5 %). Most of these (44) were ventricular ectopies requiring treatment, including four with ventricular tachycardia. However, because electrocardiographic monitoring and automated blood pressure were not in routine use in the period 1998–99, it is likely that some cardiovascular events were unnoticed.

Significant Negative Events

There were 95 patients (1.8%) who had significant morbidity (table 2). The most common problems in this group were urgent return to the operating room because of bleeding, unplanned extubations, cancellation of surgery after anesthesia induction, and transfusion. Among the study patients, there were seven patients transferred to an intensive care unit or equivalent setting for respiratory failure and two nonfatal cases of cardiac arrest. There was one death among patients at the sites included in the study (there were three other deaths during the same period at Operation Smile sites not included in the study [table 3]). Contributing factors in these critical complications included cardiac depression from halothane, uncontrolled bleeding, pulmonary aspiration, and undiagnosed preexisting medical conditions. Concerns about malignant hyperthermia led to changes in management in three cases (one cancellation), but no patients developed the condition. Return to the operat-

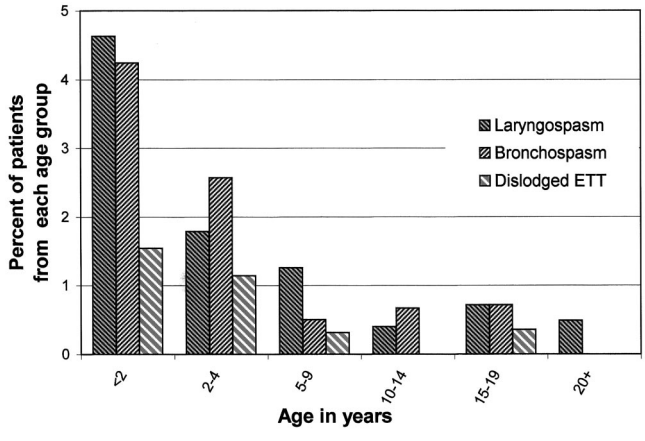

Fig. 4. Respiratory complications in the operating room.

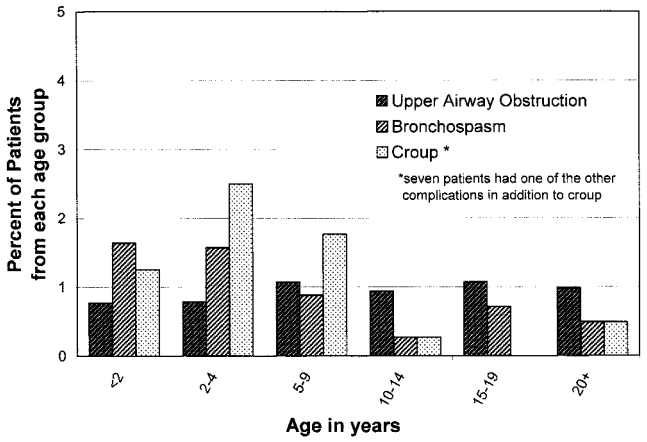

Fig. 5. Respiratory complications occurring in the postanesthesia care unit.

ing room to manage complications was reported in 45 patients (0.9%) (exploration for palatal bleeding in 38, other surgical bleeding or dehiscence in 5, and airway management in 2). An additional nine patients had repeat intubation at the end of surgery because additional surgical hemostasis was required.

Surgery was canceled after the induction of anesthesia 26 times in 25 patients (0.5%). Reasons included difficulty intubating (four), malfunction of surgical equipment (four), bronchospasm (three), suspected adverse reactions to anesthetic agents (three), excess bleeding during injections or dental work (three), intraoral abscesses (two), unacceptable hemoglobin level (two), procedure unnecessary (two), arrhythmia (one), lack of intravenous access (one), and not specified (one).

Discussion

The current study represents the first large-scale cohort analysis of anesthetic outcomes during a program of volunteer medical services abroad (VMSA). We were able to develop a profile of anesthetic techniques in use by Operation Smile volunteers and identified important morbidities worthy of further attention. Compliance with voluntary reporting of data was variable among the 200 or more anesthesia providers, as has been found in other studies that relied on self-reporting.[1–4] It is likely that most morbid events (except intensive care unit transfer or the mortality) are underreported in our data for several reasons.[1,2] First, events may have been subject to the anesthesia provider's judgment of whether it was important enough to report if it was easily managed. Second, the anesthesia provider might not have been aware of a problem when it existed. For example, some cardiovascular events would have gone undetected because of the lack of electrocardiography. Third, diagnostic ambiguities may have precluded accurate labeling. For example, we encountered some charts in which arterial hemoglobin desaturation was documented but not attributed to a particular cause. In the presence of bloody secretions, distinguishing bronchospasm from partial airway obstruction might cause confusion for some practitioners. Fourth, self-reporting requires frequent remotivation and feedback; some anesthesia providers simply did not want to be bothered with paperwork for which there was no immediate accountability. Thus, we regard our study as a "biopsy"[3] of the types of events encountered in a program of VMSA. Given the size of our sample and the number of sites included, we believe the data are representative of anesthetic techniques and occurrences in the austere surroundings of a visiting plastic surgical service in underdeveloped countries.

In our study, we sampled selected adverse events; some represented actual adverse outcome (such as laryngospasm or cardiac arrest), and others might have been classified as incidents[4] that did not result in morbidity but which, unchecked, could have caused injury (such as inadvertent extubation). Our selection was based on issues in other studies, as well as biases developed from practice by the study originators.

Anesthetic techniques were partly dictated by environmental and safety considerations. For example, the almost exclusive use of halothane and endotracheal intubation without muscle relaxation is a reflection of the availability of supplies and the needs of the clinical environment. In our study, 80.7% of tracheal intubations were performed without muscle relaxants, in contrast to the preference to use relaxants stated by 56% of anesthesia providers in a recent survey.[5] In the absence of mechanical ventilators, anesthesia providers prefer to have their patients breathing spontaneously, to keep hands free for other tasks or even to assist at another table momentarily.

Table 2. Significant Negative Events in 95 Patients

Event	Number
Return to operating room*	45
Intraoperative reintubation	38
Surgery canceled after anesthesia induced	26
Transfer to ICU (respiratory failure 5,* fluid resuscitation 2)	7
Postoperative reintubation for obstructed airway or hemostasis	9
Blood transfusion*	14
Malignant hyperthermia alert†	3
Hypoxemia due to loss of oxygen supply	2
Negative pressure pulmonary edema	2
CPR, resuscitated	2
Death	1
Red man reaction (hypotension due to vancomycin)	1
Obstruction due to retained throat pack	1
Resuscitation for hypotension*	1

* Includes patients that had more than one event. † No cases of malignant hyperthermia occurred.

ICU = intensive care unit; CPR = cardiopulmonary resuscitation.

Table 3. Mortalities Occurring during the Study Period among 9,422 Patients Treated February 1998–August 1999

1	2½ yr old, 14.5 kg, for cleft lip repair Anesthesia was induced with halothane in oxygen, atropine, and succinylcholine. A few minutes after intubation, the patient had a cardiorespiratory arrest unresponsive to resuscitative measures. Capnography was not in use. From reconstruction of events, it was unclear whether the primary event was cardiac arrest or hypoxemia.
2*	A 49-yr-old man for tracheostomy and transverse rectus abdominus skin-muscle flap jaw reconstruction (status postcancer surgery) in a tertiary hospital's microvascular surgery program Intraoperative and immediate postoperative courses were uneventful. On postoperative day 3, he developed peritonitis 2° to a perforated duodenal ulcer. Sepsis syndrome and ARDS led to death on postoperative day 5. His wife acknowledged that he had concealed a history of ulcer disease because he feared rejection for surgery.
3*	2½ yr old, 8.0 kg, for cleft lip repair Patient had developmental and gross motor delays. Anesthesia was induced with halothane in oxygen. Succinylcholine and atropine were administered for intubation because of coughing during two previous attempts. Extubation was delayed because of slow emergence. Postoperatively, he remained weak and was reintubated to manage persistent upper airway obstruction and bronchospasm. Although he seemed to improve over several hours, failure of the hospital oxygen supply 14 h postoperatively caused transient cyanosis and bradycardia while the emergency tank was secured. Patient died 16 h postoperatively. Autopsy showed chronic lung inflammation and edema.
4*	2⁸⁄₁₂ yr old, 8 kg, for cleft lip repair The patient developed severe bronchospasm intraoperatively and postoperatively. He was reintubated in the PACU. The host hospital medical staff took over case management. Patient died of respiratory failure 36 h postoperatively. The patient's mother acknowledged concealing a history of asthma for fear of rejection from surgery.

* Patients 2, 3, and 4 were from sites not participating in data collection during the 18-month study period.

ARDS = acute respiratory distress syndrome; PACU = postanesthesia care unit.

During the 18-month study period, there were four deaths among all Operation Smile patients (three of those were among the sites not included in the study), or 0.4 per 1,000 (International Missions Department, Operation Smile, Norfolk VA).

It is difficult to compare the incidence of major morbidity or mortality to other practices because the patient population, surgical procedures, and perioperative resources differ. Cohen *et al.*[6] reviewed 29,220 pediatric cases in Winnipeg, Manituba, Canada, between 1982 and 1987. Excluding neonates, there were 14 perioperative deaths and 13 intraoperative cardiac arrests (0.54 and 0.45 per 1,000, respectively). Other complications were not stratified by severity, but the risk of cardiovascular and respiratory events was two to four times higher in infants 1–12 months of age compared with older children. Children were twice as likely as adults to incur an adverse perioperative event. In a study of 40,240 cases of anesthesia use in infants and children, Tiret *et al.*[7] found 1 death (0.025 per 1,000) and major anesthetic morbidity in 27 (6 per 1,000). The authors thought that most of the incidents were avoidable. In the Pediatric Perioperative Cardiac Arrest study of 289 voluntarily reported cases from 63 hospitals, it was estimated that cardiac arrests and death occurred in approximately 0.14 and 0.04 cases per 1,000 cases of anesthesia use, respectively.[8] Ways in which VMSA activity (and therefore outcome) might differ from these studies include the possibility of undiagnosed concurrent disease and impediments to rescue under austere conditions.

Inadvertent extubation was strongly correlated with young patient age. It was generally remedied without adverse effect. Although it is often associated with the manipulations of placing a retractor for palate surgery, in half of our incidents the retractor was not in use, suggesting that other factors may play a role. In the pediatric closed claims study, inadvertent extubation accounted for 3% of claims.[9] Immediate reintubation at the end of surgery because of bleeding occurred in nine cases. Detailed prospective analysis of such problems is warranted to ascertain which events are preventable.

Cancellation of surgery after induction of anesthesia in most cases would not have been preventable. However, the discovery under anesthesia in four patients of unacceptable hemoglobin levels or misdiagnosed disease suggests procedural errors in screening that do warrant review.

Laryngospasm during intubation, requiring succinylcholine for resolution, occurred in 2.0% of our cases. In a computerized study, Olsson and Hallen[10] found that laryngospasm was more common in infants than in older children and adults, and in those with preoperative respiratory infections or bronchospasm. Their study included mask anesthetics and thus reported laryngospasm attributable to light anesthesia during surgical stimulation. Lakshmipathy *et al.*[11] found that the risk of laryngospasm in children was increased 10-fold if a household member was a cigarette smoker. Provider-related factors contributing to laryngospasm in our patients may include inexperience in assessing anesthetic depth using halothane, infrequent practice of "deep" intubation, and difficult visualization of the glottis in patients with prominent premaxillae attributable to bilateral cleft.

Bronchospasm intraoperatively or postoperatively was a problem in 2.7% of general anesthesia cases. Among them, there were several cases in which bronchospasm was triggered immediately upon tracheal intubation, persisted throughout the case despite treatment, and resolved upon removal of the tube (Mallinckrodt, Inc.,

Hazelwood, MO). It is possible that in these cases the preformed RAE tube (Mallinckrodt, Inc., Hazelwood, MO) was impinging and irritating the carina. Constitutional short stature and malnutrition characterize many Operation Smile patients, so an endotracheal tube well selected for tracheal diameter may be too long. How often bronchospasm led to prolonged postoperative problems is unknown because we did not track patients past the PACU for fever, respiratory distress, or pneumonia.

Why Are Voluntary Medical Services Abroad Different?

It is difficult to establish acceptable rates of morbidity in a surgical VMSA because the conditions are not comparable to those of previously published studies.[7,10,12–14] First, patients differ from those who would ordinarily be accepted for elective reconstructive surgery in industrialized countries.[15] Underlying illnesses, malnutrition, and advanced states of the surgical condition are common. For example, it would be highly unusual to operate on a teenage cleft palate patient for the first time in a modern western practice. Second, VMSA programs seek to treat more patients than local facilities customarily accommodate for nonurgent surgery. This demands effective screening with minimal facilities, rapid case turnover, brief PACU stays, and assurances of postoperative stability with minimal professional supervision. Third, practitioners must work without modern anesthesia machines, ventilators, or monitoring capacity.[16,17] VMSA programs must weigh whether to use local host country equipment or undertake the expense of acquiring and shipping their own. However, even portable equipment frequently does not match the standards of a modern U.S. operating room. Fourth, VMSA operating teams are composed of practitioners who have not previously worked together, and they bring diverse skills, personalities, and expectations of each other's roles. Undoubtedly, the interpersonal aspects of team formation play a role in the occurrence of complications and their efficient resolution. Fifth, adjustment to a different surrounding may also be difficult: Approximately one third of Operation Smile anesthesia volunteers have not been on previous VMSA trips. In addition, some host country participants have had little experience with elective pediatric cases.

The current study serves as first step in establishing a profile of perioperative morbidity for a large charity providing VMSA surgery. Although data were incomplete, the most likely deficit is in underreporting the frequency of events of mild to moderate severity. Nonetheless, we think it is a substantial sample of the problems that do arise and serves to suggest areas for further evaluation. We are not aware of other such organized attempts to monitor adverse events for a program of VMSA. Concern for developing evidential bases for volunteer practices in underdeveloped countries has only recently begun to evolve.[18]

Establishing a quality improvement program for a program of VMSA involves the following barriers not encountered in an ordinary hospital practice:

1. Geographic diversity. During the study period, services were provided at 69 sites in 18 countries worldwide. Teams included more than 200 anesthesia providers originating from many of those countries. For each site visit, a new team is constituted for 2 weeks, then disbanded. Thus, it is difficult to track events and practitioners consistently.
2. Provider variability. Anesthesia providers who are well adapted to practice in their home setting may not adapt well to the austerity and necessary improvisation of medical services abroad. Given the varied geographic origins and differences in training and experience, it is difficult to establish more than paper credentials for volunteers. In most cases, close observation by an experienced volunteer during a site visit provides the best insights about a professional's practice. Future studies of provider-related factors in anesthetic complications should include evaluation of volunteers' familiarity with pediatric cases, surgery involving the airway, and medicine in underdeveloped countries.
3. Accountability. The quality of charting and reporting were extremely variable. Trips are brief and teams quickly assembled and disbanded; anesthesia providers are not readily held accountable for completing paperwork. Voluntary organizations have few sanctions to compel thorough record keeping.
4. Event reportability. The threshold for interpreting an event as adverse might differ among anesthesia providers. Based on informal discussions, some anesthesia providers did not regard hypotension or bradycardia attributable to halothane as significant events. Similarly, because of the regular practice of "deep" intubation, some anesthesia providers thought that laryngospasm was not a significant event. It is also known that physicians and nurses tend to minimize error because of strong training biases to regard good practice as error free.[19] On the contrary, errors are a regular occurrence; not all errors result in harm, and even when they do, they might occur within the scope of good practice.[4] Developing a culture in which accurate record-keeping and reporting of events is valued can be effective in improving accuracy.[20]

The ultimate goal of quality review is to improve practices. The results of the current study suggest that respiratory events, airway misadventures, and uncovering undiagnosed illnesses may be appropriate targets for practice improvements. Methods for addressing the problems might include more thorough preoperative

evaluation, preoperative prophylaxis for reactive airways disease, education of providers regarding specific issues, and more extensive intraoperative monitoring (*e.g.*, capnography). Additional study of specific problems will be needed to uncover the root causes. Nonetheless, changes that are expected in the near future from Operation Smile (International Missions Department, Operation Smile, Norfolk VA) include adopting the Standards for Basic Anesthetic Monitoring of the American Society of Anesthesiologists for monitoring practices.§§ In addition, there are plans to change from the use of halothane to sevoflurane, although it is not clear whether that will have an impact on overall morbidity.

The current study did not identify manpower issues related to outcomes. In 2000, Operation Smile has established minimal manpower requirements that include the following: one "float" anesthesia provider for every five tables, attendance by two anesthesia providers at every induction of general anesthesia, and staffing of each table by an Operation Smile–credentialed volunteer. Thus, a host country volunteer whose own hospital is the host site is required to work under supervision of a credentialed volunteer on a first mission.

Anesthetic techniques and problems in medical services abroad are different from those of both developed countries and the host countries for programs of VMSA. Therefore, the profile of complications is probably unique to this type of practice and not necessarily the same as reported in hospital-based studies from tertiary-level care facilities in developed countries. International voluntary organizations should develop tools for ongoing evaluation of their practices. This is necessary to elucidate patterns of problems and to establish baselines from which improvements can be measured.

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§§ American Society of Anesthesiologists, 520 North Northwest Highway, Park Ridge, Illinois, 60068. Document may also be found at the following Web site: http://www.asahq.org/Standars/02.html. Accessed June 30, 2001.

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