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Adverse Anesthesia Outcomes: A Retrospective Study of an Ambulatory Surgical Center versus a Dental Office Setting

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ADVERSE ANESTHESIA OUTCOMES: A RETROSPECTIVE STUDY OF AN AMBULATORY SURGICAL CENTER VERSUS A DENTAL OFFICE SETTING

A thesis submitted in partial fulfillment of the requirements for the degree of Masters of Science in Dentistry at Virginia Commonwealth University.

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Abstract

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Purpose: The purpose of this study was to compare the adverse events that occur with general anesthesia for dental rehabilitation between a hospital setting and dental clinic setting. **Methods:** A retrospective chart review was performed examining patients who had received dental rehabilitation with general anesthesia at the Virginia Commonwealth University Department of Pediatric Dentistry. Subjects were either treated in the Pediatric Dental Clinic or the Hospital Ambulatory Surgery Center (ASC) from July 2005 to December 2006. Anesthesia records of induction, intubation, maintenance, emergence and recovery were compared between the two settings.

Results: There were a total of 422 charts reviewed with n=193 cases in the dental clinic and n=229 cases in the ASC. Patients in the dental clinic setting were slightly older (t = 2.63, df = 420, p-value = 0.0089), and healthier (chi-square = 45.9, df = 2, p-value < .0001). During the induction and intubation phase there were no differences between settings. During the maintenance phase, the occurrence of blood pressure drop of greater than 20% of baseline (p-value < 0.0001) and light anesthesia (p-value < 0.0001) were higher in the hospital-based ambulatory setting. During the emergence phase, the occurrence of delayed wakeup (p-value < 0.0001) was higher in the hospital-based ambulatory setting. In the post-operative phase, the occurrence of pain (p-value < 0.0001) was greater in the hospital-based ambulatory setting.

Conclusion: Overall, the prevalence of adverse events occurring with dental rehabilitation under general anesthesia in the dental clinic setting was lower compared to adverse events in the hospital-based ambulatory surgical setting.

Introduction

Over 22 million children are affected with dental caries, making it the single most common disease of childhood that is either not self-correctable or amenable to a course of antibiotics.[1] As the most prevalent disease of childhood, dental caries has enormous health and social consequences for children and their families. The oral health of preschool children is of particular concern. Dental decay in these children, generally referred to as early childhood caries (ECC) can begin soon after the teeth emerge and progress rapidly to the cavitation stage in only 6 to 12 months, requiring intervention in a very short time span.[2] The ability to perform effective and efficient dental treatment for a young fearful child while instilling a positive dental attitude is extremely challenging. Often, the practitioner caring for a child with ECC must employ advanced behavior management techniques. These may include medical immobilization and/or conscious sedation or general anesthesia.

The discipline of behavior management is an ever-changing component of pediatric dentistry. As parental attitudes and societal norms evolve, pediatric dentists must reexamine currently accepted practices to ensure optimal patient care. There exists a population of patients who because of their need for extensive treatment, acute situational anxiety, pre-cooperative or uncooperative age-appropriate behavior, immature

cognitive functioning, disabilities, or medical conditions, it is more cost-effective, efficient, and humane to treat these children with general anesthesia.[3]

In the UK, Murray et al. documented a decline in the number of school-aged children treated with general anesthesia over the past 20 years.[4] Jamieson et al. has shown that general anesthesia cases are increasing in Australia. Their study shows an increase in pre-school-aged male, indigenous patients that receive dental care with general anesthesia.[5] In the U.S. is it unknown whether the demand for dental rehabilitation with general anesthesia has increased, decreased, or remains steady.

While changes in state laws have provided for insurance coverage for the general anesthesia used with dental rehabilitation, federal Employee Retirement Income Security Act (ERISA) statute continues to limit access to dental care under general anesthesia. Private corporations that are self insured, do not have to abide by these state laws and do not have to provide coverage for dental anesthesia as ERISA does not mandate coverage. The need for insurance coverage of general anesthesia for dental treatment has been reaffirmed by the American Academy of Pediatric Dentistry's (AAPD) Policy on Third-party Reimbursement of Medical Fees Related to the Sedation/General Anesthesia for Delivery of Oral Health Services.[6] Future trends most likely will show a consistent demand for general anesthesia with dental treatment in young children.

In 1985, the AAPD adopted its Clinical Guideline on the Elective Use of Minimal, Moderate, and Deep Sedation and General Anesthesia for Pediatric Dental Patients.[7] The AAPD endorses the in-office use of general anesthesia on select pediatric dental patients administered either by a trained, credentialed, and licensed pediatric

dentist, dental or medical anesthesiologist, or certified registered nurse anesthetist in an appropriately equipped and staffed facility. The AAPD defines general anesthesia as a drug-induced loss of consciousness during which patients are nonarousable, even by painful stimulation. At this level of unconsciousness, the ability to independently maintain ventilatory function is often impaired. Patients undergoing general anesthesia require assistance in maintaining a patent airway. Positive-pressure ventilation may be required due to depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may also be impaired.[7,8]

Throughout the1980's, many surgical procedures under general anesthesia that had been previously performed in hospitals began to be performed in freestanding ambulatory surgery centers (ASCs). By the 1990s, over 50% of all surgeries were performed in an ambulatory setting. Beginning in the 1990s there was another shift, with greater numbers of surgical procedures being performed in physician offices that had previously been performed in ASCs. Although there are few data on the actual numbers of in-office surgeries, it is estimated up to 1.2 million procedures per year are currently being performed nationwide in an office setting.[9]

As a consequence of these changes, the demand for general anesthesia for procedures in outpatient settings has significantly increased. This has occurred in settings such as physician offices, dental offices, subspecialty procedure suites, imaging facilities, emergency departments, and ambulatory surgery centers. Due to this need for both elective and emergency use of general anesthesia in nontraditional settings, the American Academy of Pediatrics (AAP) and the AAPD have established guidelines for

the monitoring and management of pediatric patients during and after general anesthesia cases.[7] The AAPD requires that at least 3 individuals (anesthesia care provider, treating dentist, and support staff) be present during in-office deep sedation/general anesthesia techniques. The anesthesia care provider must be licensed dental and/or medical practitioner with appropriate state certification for deep sedation/general anesthesia. They must have completed an anesthesia residency or its equivalent as approved by the American Dental Association (ADA), and/or American Medical Association (AMA). The anesthesia care provider must be licensed in the state in which he/she practices. In accordance with state practice acts, a certified registered nurse anesthetist (CRNA) can provide sedation and/or general anesthesia under the supervision of a dentist, if the dentist has completed training in deep sedation/general anesthesia and is licensed as appropriate to state law.[7, 8, 10-12] CRNA's are licensed independent practitioners who practice in accordance with the standards set forth by the American Association of Nurse Anesthetists.[12]

Dental procedures under general anesthesia for pediatric patients can be associated with serious risks such as airway obstruction, laryngospasm, bronchospasm, allergic reactions, malignant hyperthermia, and cardiopulmonary impairment (i.e. bradycardia, tachycardia).[13] These adverse events during and after procedures may be minimized, but not completely eliminated, by a careful review of the patient's underlying medical conditions and consideration of how the procedure might affect or be affected by these conditions. Appropriate drug selection for the intended procedure as well as the presence of a professional with the skills needed to rescue a patient from an adverse

response is essential. Appropriate physiologic monitoring and continuous observation by personnel not directly involved with the procedure allows for accurate and rapid diagnosis of complications and initiation of appropriate rescue measures.[14]

The AAPD also states that the dental office must provide quality of care equal to that of the hospital-based facility. Prior to subjecting a patient to general anesthesia, the patient must undergo a preoperative health evaluation. The AAPD recommends that high-risk patients should be treated in a facility properly equipped to provide for their care. The dentist and anesthesia care provider must work together to develop mechanisms of quality assurance.[7, 8]

Coté et al studied factors that contribute to adverse sedation events in children undergoing various procedures by specialists including dentists, radiologists, cardiologists, and surgeons. This study compared a wide variety of procedures done under various types of sedation in a hospital-based facility (hospital, emergency department, or surgical-center) or a non-hospital-based facility (office or freestanding imaging facility). In this study, they examined a wide range of outcomes, ranging in severity from no harm to death. They noted that patients receiving anesthesia in non-hospital-based settings compared with hospital-based settings were older and healthier. Adverse outcomes (permanent neurological injury or death) occurred more frequently in a non-hospital-based facility, whereas successful outcomes occurred more frequently in a hospital-based setting. Inadequate resuscitation was more often associated with a non-hospital-based setting. Inadequate and inconsistent physiologic monitoring (particularly failure to use or respond appropriately to pulse oximetry) was another major factor

contributing to poor outcome in all venues.[13,14] Previous reviews of morbidity and mortality data have shown mixed results illustrating the difficulty in obtaining and comparing this information. Obtaining adverse incident and death information for office-based operations, ASCs, and hospital settings, as well as total cases performed in both settings, is exceedingly difficult. In most states this information simply does not exist.[15-17] A study by Lee et al., examined the mortality risks associated with dental care under general anesthesia in a hospital setting. They sent a survey to hospitals regarding mortality and found that no deaths occurred in the 22,615 dental cases performed using general anesthesia. This study was limited in that it only examined mortality and did not identify any morbidity (i.e. adverse events) associated with dental care under general anesthesia.[18] Cravero et al looked at morbidity risks associated with pediatric sedation and anesthesia for procedures held in an office setting. They found the incidence of serious adverse events in pediatric sedation/anesthesia to be low, reporting only two cases of serious morbidity (1 aspiration and 1 hypoxic episode). Yet, they did find that a potential to harm exists at the rate of one incident per 89 cases with the most common adverse event being oxygen desaturation.[19]

There are no studies to date that examine and compare the occurrence of adverse events during pediatric dental general anesthesia cases in a hospital setting versus a dental clinic setting.[15-22] The objective of this study was to examine the prevalence of adverse events with general anesthesia, making a comparison between a dental clinic setting and hospital-based ambulatory surgical setting.

Materials and Methods

Design

This was a retrospective chart review of patient records who have had dental rehabilitation through general anesthesia with the Department of Pediatric Dentistry at the Virginia Commonwealth University School of Dentistry. The inclusion criterion was all patients who had dental rehabilitation in either the dental clinic or the hospital-based ambulatory surgery center (ASC) between July 1, 2005 and December 31, 2006.

Sample and Data Collection

Data collection was completed at the chart level for both settings. Each chart was assigned a case number so that no individual identifiers were collected. The study variables extracted from the chart consisted of age, gender, ASA status, and adverse events categorized according to the following five phases of general anesthesia: induction, intubation, maintenance, emergence and recovery. A list of the 22 types of adverse events contained in the five phases of anesthesia and their description is presented in Appendix A. Data was collected from 193 dental clinic cases and 229 hospital-based ambulatory surgery center cases. This study was approved for human subjects by the Virginia Commonwealth University Institutional Review Board.

Statistical Analysis

This study tested for equivalence in the prevalence of adverse events between the dental clinic and hospital setting which required the setting of equivalence bounds before the study began. These bounds represented a reasonable range within which the risk of adverse events at either setting would be considered equal. The equivalence bounds were set at a prevalence rate of 5. This means that if the occurrence rate of adverse events in the dental office setting is within 5 percent of the hospital setting, then the risk would be considered equivalent. The equivalence test is based on the 95% confidence interval of the difference between the two settings, which had to be within + or – 5 percent for the two settings to be equivalent. This study had approximately an 80% power to reject the null hypothesis that the risks in either surgical setting were not equivalent.

The analyses consisted of the generation of descriptive statistics for extracted variables and patient characteristics. The age, health status, and gender of patients in the two clinical settings were compared using a t-test or chi-square analysis. To compare the adverse events, a separate logistic regression for each of the adverse events was used to test for a relationship with: gender, ASA, age, and for a difference between the dental clinic and hospital setting. Additionally, an exact p-value for the clinic difference within this logistic regression model was provided. Follow-up analyses methods included Fisher's exact p-value and the Wilcoxon test.

Results

Descriptive results for both surgical settings

The final study sample consisted of 422 charts 54% (N = 229) from the hospital-based ambulatory surgery center (ASC) and 46% (N = 193) from the dental clinic setting. The description of the two patient populations is shown in Table 1. Children treated in the dental clinic setting were slightly older (t = 2.63, df = 420, p-value = 0.0089), more healthy (chi-square = 45.9, df = 2, p-value < .0001) and consisted of a larger proportion of female patients (Fisher's exact p-value = 0.0022). These patient differences were taken into account when making comparisons between the two surgical settings.

Adverse Events in the Dental Clinic Setting

In the induction phase, the adverse events noted were laryngospasm (3 events, 1.6%), desaturation < 90% (1 event, 0.5%) and heart rate drop below 60 (1 event, 0.5%). During the intubation phase, the adverse events noted were; difficult ventilation (3 events, 1.6%), difficult intubation (6 events, 3.1%), and right bronchial mainstem intubation (1 event, 0.5%). During the maintenance phase the only adverse event noted was a drop in blood pressure of greater than 20% of base reading (2 events, 1.0%). During the emergence phase the adverse events noted were; desaturation <90 (2 events, 1.0%), vomiting (1 event, 0.5%), and delayed wakeup (> 9 minutes) (91 events, 48.1%).

In the post-operative phase the adverse events noted were respiratory difficulty (1 event, 0.5%), pain (3 events, 1.6%) and nausea/vomiting (4 events, 2.1%). Pain was defined as discomfort in the post-anesthesia care unit requiring the administration of pain medication for relief.

Adverse Events in the Hospital-based Ambulatory Surgical Setting

During the induction phase the adverse events noted were bronchospasm in one patient (0.4%), desaturation < 90% in 7 patients (3.1%), heart rate below 60 in four patients (1.7%), and vomiting in one patient (0.4%). During the intubation phase, the only adverse event noted was difficult intubation in seven patients (3.1%). During the maintenance phase the adverse events were; bronchospasm in one patient (0.4%), blood pressure drop of greater than 20% below base in 37 patients (16.2%), heart rate below 60 in two patients (0.9%), and light anesthesia in 37 patients (16.2%). During the emergence phase, the only adverse events noted were a drop in SpO_2 < 90% in 22 patients (9.6%) and delayed wakeup (> 9 minutes) in 172 patients (76.1%). In the post-operative phase, the adverse events noted were respiratory difficulty in two patients (0.9%), wheezing in three patients (1.4%), pain observed by 43 patients (19.7%) and nausea/vomiting in four patients (1.8%).

Comparison of Adverse Events in the two Settings

Table 2 summarizes the comparisons between surgical settings for adverse events in each of the five phases of general anesthesia. A logistic regression of these adverse

events tested for a difference in surgical setting (ASC versus dental clinic) adjusting for gender, ASA classification, and age. Additionally, an exact p-value for the surgical setting difference within this logistic regression model was provided.

During the induction phase, the only significant relationship was between age (older patients) and a heart rate drop below 60 (p-value=0.0315) (Figure 1). During the intubation phase, there were no differences between the two surgical settings or with demographic factors (Figure 2). There were a couple of differences during the maintenance phase (Figure 3). The ASC has significantly more instances of a blood pressure drop greater than 20% below baseline and documentation of light anesthesia compared to the dental clinic setting (p-value < .0001). There was a significant relationship between a child's age and a heart rate drop below 60 (p-value =0.0186). The two instances of low heart rate were in older patients (10 and 16 years).

During the emergence phase, there were two significant differences between surgical settings (Figure 4). The ASC had an increased number of desaturations SpO_2 < 90% (p-value=0.0011) and delayed wake-up times of greater than 9 minutes (p-value <0.0001). The median emergence time in the ASC was 12 minutes and in the dental clinic it was 9 minutes (ASC mean = 12.8, SD = 4.8 versus dental clinic mean = 9.6, SD = 5.68). The two groups had significantly different emergence times (Kaplan Meier survival analysis, Wilcoxon p-value < .0001). ASA classification was also significantly related to delayed wake up times with less healthy patients having longer wake-up times. In the post-anesthesia phase, the ASC had significantly higher instances of pain recorded than in the dental clinic setting (p-value < .0001) (Figure 5). Child's age (older patients)

was also significantly associated with nausea/vomiting in the post-operative phase (p-value=0.0044).

Discussion

Safety concerns about pediatric sedation have moved many national organizations to produce statements and guidelines regarding the delivery of care. The Joint Commission on Accreditation of Hospitals, the American Society of Anesthesiologists, the American Academy of Pediatrics, the American College of Emergency Physicians, and the American Academy of Pediatric Dentistry have all published some form of guidelines concerning sedation of children[7,8,10,12,19]. These recommendations have been made on the limited studies available and are not based on actual incidence of complications in pediatric sedation. Furthermore, there are limited studies that have examined the practice of general anesthesia for dental rehabilitation in pediatric patients in the various surgical settings.[19] The incidence of adverse events in these settings is largely unknown.

To compound the problem even more, the trend has moved to performing sedation procedures in non-hospital-based facilities. To date, there have been no studies that have examined general anesthesia for pediatric dental rehabilitation procedures in the dental clinic setting. Cote et al highlighted the fact that adverse events during sedation do occur and are largely predictable. A limitation of that study was that it only looked at injury in the broadest sense (severe hypoxia, neurologic injury, death, etc) and did not

look at the frequency of more common adverse events.[13] Other studies have looked at individual events such as mortality, anxiety, and postoperative morbidity but have not compared adverse events between various surgical settings[16-18].

This investigation specifically sought to compare and analyze the occurrence of adverse events between the dental clinic setting and the hospital-based ambulatory surgical setting. Adverse events in each phase (induction, intubation, maintenance, emergence, and PACU) of general anesthesia were observed. The results showed that more adverse events occurred in the hospital-based ambulatory surgical center (ASC) than in the dental clinic setting. This rejects our null hypothesis that there is equal prevalence of adverse events in both settings. Although, during the induction and intubation phase there were no differences between settings, all other settings had significant differences. During the maintenance phase, the occurrence of blood pressure drop of greater than 20% of baseline and light anesthesia were higher in the hospital-based ASC. During the emergence phase, the occurrence of delayed wakeup was also higher in the hospital-based ASC. Finally in the post-operative phase, the occurrence of pain was also greater in the hospital-based ASC.

A limitation of the study is that it was a retrospective chart review which means pre-existing data was used to make comparisons between the two surgical settings. Differences in patient selection, charting, the possibility of artifacts, and a lack of a standardized anesthesia monitoring record were all factors which may have contributed to the study biases.

The hospital-based ASC used a computerized charting system. All times, medications, personnel, vital signs, adverse occurrences and materials used are recorded electronically in real-time through the hospital computer system. The dental clinic setting uses a handwritten method of anesthesia monitoring charted on paper. This means that the anesthesia provider records all of the above mentioned information by hand. This may have biased the studies results in recording adverse events. To compound the issue of differences in charting between the two settings, with electronic charting there is also the occurrence of artifacts. Artifacts are the mechanical disruptions during monitoring of vital signs that create incorrect readings, but are still picked up by the computerized system in real-time. Interference from the surgeon leaning on the blood pressure cuff, or the pulse oximeter slipping off the finger, for instance, requires documentation that the vital sign recorded is in error due to artifact. If artifacts are not noted, then in review of the charts these erroneous values are recorded as adverse events showing a false positive for an adverse event that did not occur. Conversely, in the dental clinic setting, the anesthetist, who is recording by hand may be busy solving the problem at hand, whether it is a real desaturation or the displacement of a sensor, and then does not go back and chart the actual drop in vital signs.

Hospitals are considered a highly monitored environment and capable of providing the ultimate safety net and definitive care that is needed for patients with complex co-morbid conditions. For this reason, the treatment of patients who have a significant medical history and co-morbidities has historically been in a hospital setting. This study found a similar trend. Patients in the ASA category I and II were treated in

the dental clinic setting whereas in the hospital-based ASC setting, the population was younger and had a higher proportion of medically compromised patients in addition to the ASA I patients (ASA I, II, and III). Patients that had any respiratory issues such as poorly controlled asthma and were set up for their surgeries in the ASC setting, while well controlled asthmatics were considered suitable for treatment in the dental clinic setting.

For future studies, there is a need to create a more uniform and standardized method of data collection for anesthesia charting. A prospective study with standardized data collection procedures would allow for less biased results. We propose the use of a data collection sheet to remind the anesthesia provider to chart specific critical events. It would serve as a check off sheet and a better means to note the incidence of adverse events. Future research may consist of a prospective study with standardized anesthesia monitoring and data collection using the same inclusion criteria as the present study in order to better examine the safety of anesthesia comparing the dental clinic and hospital-based settings.

Conclusions

1. This study showed a higher prevalence of adverse events in a hospital-based ambulatory surgical center (ASC) setting as compared to a dental office setting.
2. Demographic differences showed that the patients treated in the dental office setting were older and healthier than those treated in the ambulatory surgical center.
3. Controlling for demographic differences, the phases of anesthesia that showed a significantly higher occurrence of adverse events in the hospital-based ASC included maintenance, emergence, and post anesthesia.
4. The higher occurrence of adverse events in the hospital-based ASC may be due to the false positives that resulted from artifacts.
5. Further study is required with standardized anesthesia monitoring methods in order to better assess the safety of general anesthesia comparing the dental clinic and hospital-based settings.

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Table 1: Description of Patients

	Surgical Setting		
Characteristic	ASC (n = 229)	Dental Clinic (n=193)	p-value
Age (mean)	5.12	5.89	0.0089
SD	3.19	2.70	
ASA Status	Percent (n)		
1	57 (130)	88 (170)	<.0001
2	41 (93)	12 (23)	
3	3 (6)	0 (0)	
Gender	Percent (n)		
F	37 (85)	52 (101)	0.0022
M	63 (144)	48 (92)	

Note: The clinic settings were compared using a two group t-test (for age) and chi-square analysis (for ASC and gender).

Table 2: Adverse Events in the Ambulatory Surgical Center and Dental Clinic Settings

	Percent (N)				p-value				
Adverse Events	ASC		Dental Clinic		Gender	ASA	Setting	age	exact
I:Laryngospasm	0.0	(0/229)	1.6	(3/193)	0.4785	0.9969	0.9149	0.3506	0.2298
I:Bronchospasm	0.4	(1/229)	0.0	(0/193)	0.8744	0.9855	0.8913	0.5996	1.0000
I:SpO2 < 90%	3.1	(7/229)	0.5	(1/193)	0.1452	0.9864	0.1262	0.9711	0.1216
I:HR < 60	1.7	(4/229)	0.5	(1/193)	0.9506	0.5616	0.7078	0.0315*	1.0000
I:Vomiting	0.4	(1/229)	0.0	(0/193)	0.9355	0.9982	0.9449	0.6332	1.0000
IN:Diff. Ventilating	0.0	(0/229)	1.6	(3/193)	0.6839	0.9976	0.9238	0.7934	0.2766
IN: Diff. Intubation	3.1	(7/229)	3.1	(6/193)	0.4452	0.5621	0.8794	0.0873	1.0000
IN:R Mainstem	0.0	(0/229)	0.5	(1/193)	0.9419	0.9979	0.9414	0.4178	1.0000
IN:Esophageal Intubation	0.0	(0/229)	1.0	(2/193)	0.7164	0.9972	0.9404	0.0894	0.5903
M:Bronchospasm	0.4	(1/229)	0.0	(0/193)	0.8185	0.9764	0.9129	0.3712	1.0000
M:BP Drop >20% base	16.2	(37/229)	1.0	(2/193)	0.5160	0.3261	0.0002	0.3742	<.0001*
M:HR < 60	0.9	(2/229)	0.0	(0/193)	0.9015	0.6811	0.9398	0.0186*	0.1515
M:Light Anesthesia	16.2	(37/229)	0.0	(0/193)	0.4996	0.1217	0.9319	0.5307	<.0001*
E:Bronchospasm	0.0	(0/229)	0.0	(0/193)	NA				
E:laryngospasm	0.0	(0/229)	0.0	(0/193)	NA				
E:SpO2 < 90%	9.6	(22/229)	1.0	(2/193)	0.9277	0.6570	0.0048	0.2724	0.0011
E:Vomiting	0.0	(0/229)	0.5	(1/193)	0.9419	0.9979	0.9414	0.4178	1.0000
E:Delayed Wakeup	76.1	(172/226)	48.1	(91/189)	0.5411	0.0501*	<.0001	0.7760	<.0001*
P:Respiratory diff.	0.9	(2/218)	0.5	(1/193)	0.3168	0.3522	0.9008	0.6097	1.0000
P:Wheezing	1.4	(3/218)	0.0	(0/193)	0.2993	0.6544	0.9256	0.8275	0.4534
P:Pain	19.7	(43/218)	1.6	(3/193)	0.7172	0.9704	<.0001	0.2200	<.0001*
P:Nausea/Vomiting	1.8	(4/218)	2.1	(4/193)	0.5101	0.2610	0.4782	0.0044*	0.6966

Note: If there were no missing values, ACC total N = 229, GA total N = 193, *p-value $\leq$ 0.05

Phases of Anesthesia: I: Induction, In: Intubation, M: Maintenance, E: Emergence, P: Post Anesthesia.

Figure 1. Adverse Events During the Induction Phase

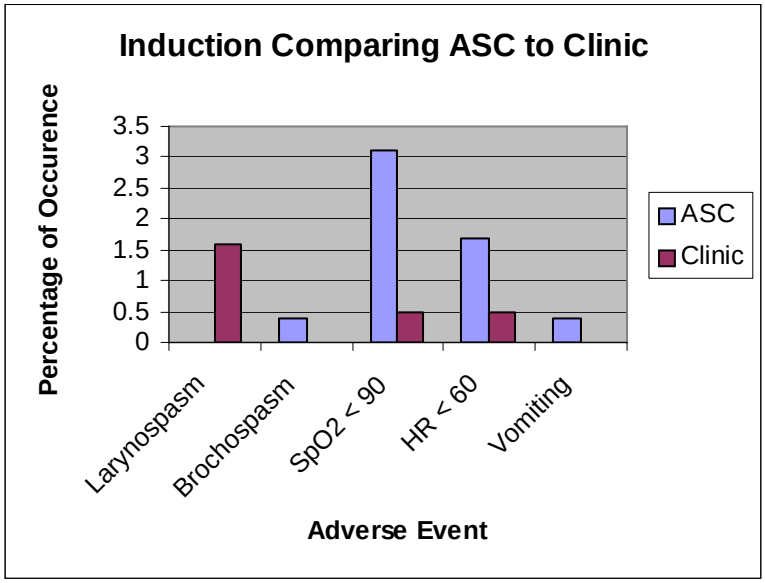


Figure 2. Adverse Events During the Intubation Phase

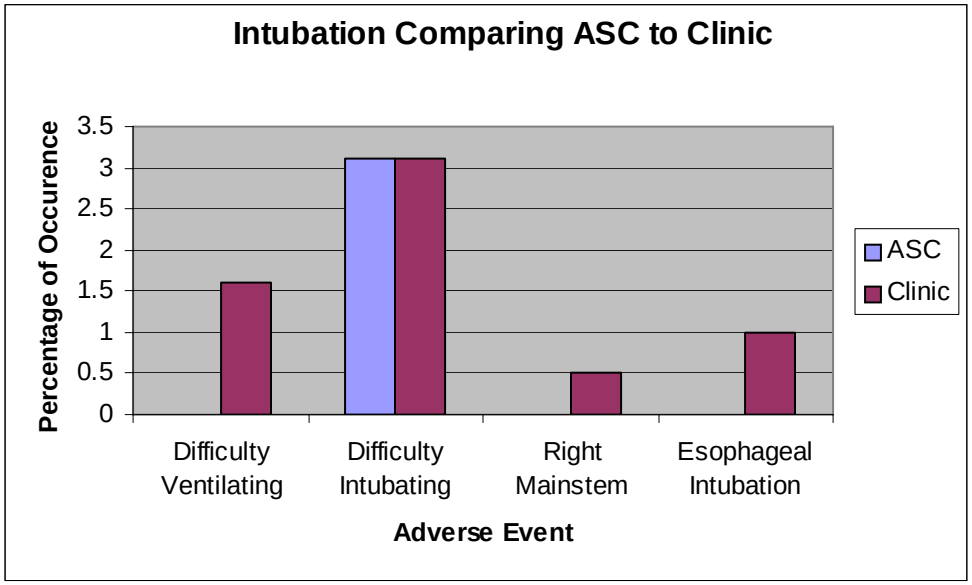


Figure 3. Adverse Events During the Maintenance Phase

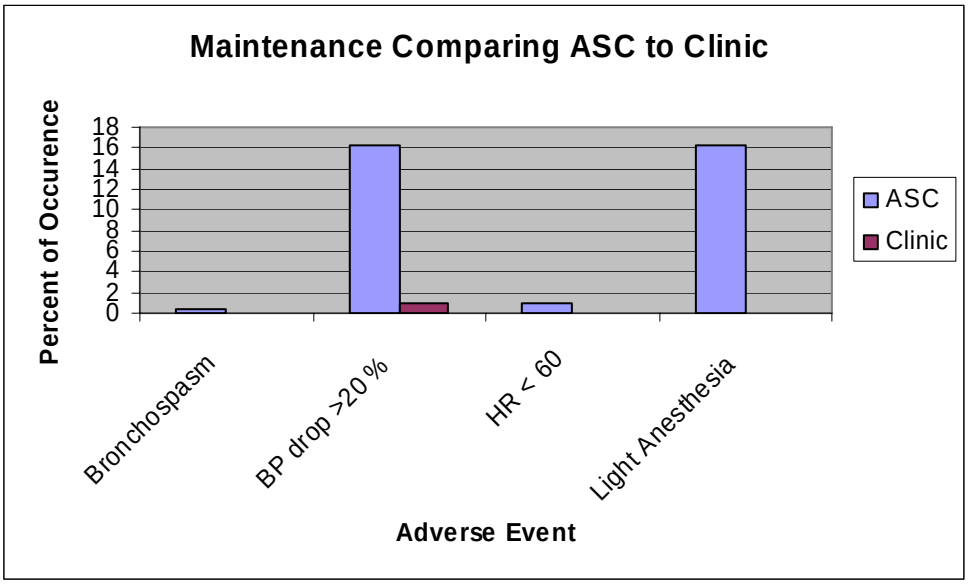


Figure 4. Adverse Events During the Emergence Phase

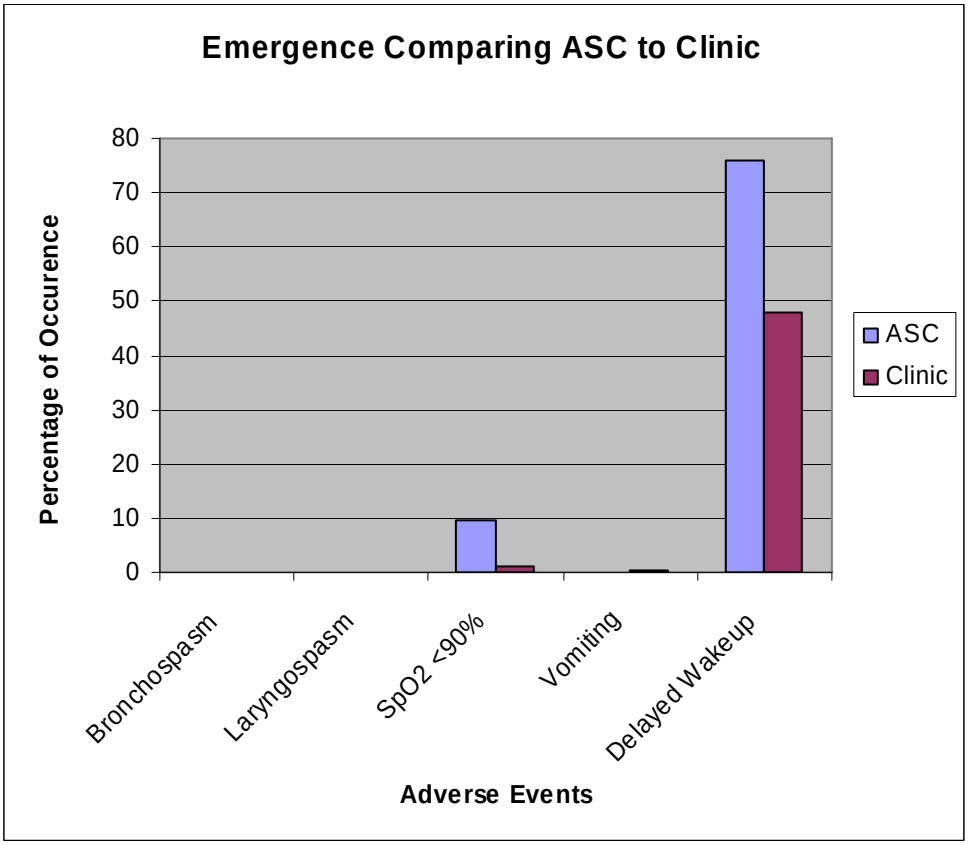
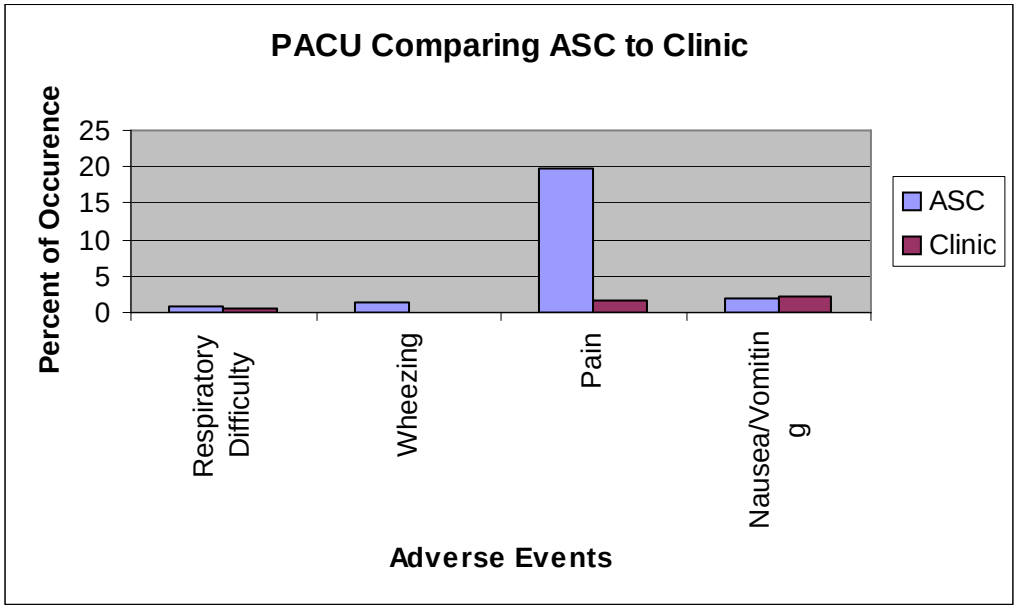


Figure 5. Adverse Events In the Post Anesthesia Care Unit



APPENDIX A

Description of Adverse Events

Phase of Anesthesia	Adverse Event	Description
Induction	Laryngospasm	The forceful closure of the vocal cords caused by stimulation of the superior laryngeal nerve causing the inability to ventilate; can be partial or complete.
	Bronchospasm	Difficulty breathing caused by the constriction of the muscles in the walls of the bronchioles
	SpO_2<90	Desaturation below 90 percent
	HR < 60	Heart rate drop below 60 beats per minute
	Vomiting	Emesis
Intubation	Difficulty Ventilating	Difficulty moving air into patients lungs
	Difficult Intubation	Failing to intubate in two attempts or less by an experienced provider
	Right Mainstem Intubation	The endotracheal tube placed into the right bronchial trunk
	Esophageal Intubation	The endotracheal tube placed into the esophagus
Maintenance	Bronchospasm	Difficulty breathing caused by the constriction of the muscles in the walls of the bronchioles
	BP Drop >20%	Blood pressure drop of greater than 20% of baseline BP
	HR < 60	Heart rate drop below 60 beats per minute
	Light Anesthesia	Patient stimulated during treatment; “bucking”
Emergence	Bronchospasm	Difficulty breathing caused by the constriction of the muscles in the walls of the bronchioles
	Laryngospasm	The forceful closure of the vocal cords caused by stimulation of the superior laryngeal nerve causing the inability to ventilate; can be partial or complete.
	SpO_2 < 90	Desaturation below 90 percent
	Vomiting	Emesis
	Delayed Wakeup	Emergence time of greater than 9 minutes after anesthesia gas discontinued.
PACU	Respiratory Difficulty	Difficulty breathing
	Wheezing	Continuous course whistling sound during respiration
	Pain	Discomfort experienced by patient in the PACU requiring medication
	Nausea/Vomiting	Sensation of needing to throw-up/emesis

VITA

Gaurav Agarwal was born on September 15, 1977 in Utter Pradesh, India. He graduated from Lake Braddock High School, Burke, Virginia 1995. He attended James Madison University in Harrisonburg, Virginia, where he received his Bachelor of Science in 1999 in Health Sciences. Dr. Agarwal received his Doctor of Dental Surgery from The Medical College of Virginia at Virginia Commonwealth University, Richmond, Virginia in 2005.