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Comparison of Emergence Behavior in Pediatric Dental Patients Undergoing General Anesthesia with Sevoflurane versus Desflurane

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A COMPARISON OF EMERGENCE BEHAVIOR IN PEDIATRIC DENTAL PATIENTS UNDERGOING GENERAL ANESTHESIA WITH SEVOFLURANE VERSUS DESFLURANE

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

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Abstract

COMPARISON OF EMERGENCE BEHAVIOR IN PEDIATRIC DENTAL PATIENTS UNDERGOING GENERAL ANESTHESIA WITH SEVOFLURANE VERSUS DESFLURANE

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Purpose: To determine which maintenance gas (sevoflurane versus desflurane) resulted in a faster emergence from general anesthesia and investigate the patient's emergence agitation.

Methods: One group was maintained during general anesthesia with sevoflurane and the other with desflurane. Upon emergence the patient's behavior was evaluated.

Results: The average emergence time for desflurane was 9.8; while the average for sevoflurane was 13.98 minutes. Patients who received premedication had an emergence time of 15.43 minutes, while patients who received no premedication emerged after 8.34 minutes.

Zofran® was a significant predictor of purposeful actions. Patients were more aware of their surroundings when they received Zofran® compared to patients who did not receive Zofran®.

Conclusion: Maintaining with desflurane and not premedicating patients allowed for a faster emergence from general anesthesia. Patients given Zofran® in their IV during the surgery had less emergence agitation then their counterparts.

Introduction

Early childhood caries is defined by the American Academy of Pediatric Dentistry (AAPD) as the presence of one or more decayed, missing, or filled (dmf) teeth in anyone under the age of 71 months.[1] Dental caries is an infectious process that can start as soon as the first tooth erupts into the mouth and it can spread rapidly from one tooth to the next. Dental caries can lead to undesirable outcomes if left untreated that can affect all aspects of the child's life. The AAPD recognizes that there is a population of patients who cannot, for one reason or another, receive dental treatment using nonpharmacological techniques.[1] This 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.[2]

Induction for general anesthesia can be done via gases delivered by a facemask or medicine delivered intravenously (IV). Many of the pediatric patients undergoing general anesthesia will not tolerate the insertion of an IV while they are awake and alert. Therefore in the pediatric population, general anesthesia is often induced with gases (inhalants) delivered through a facemask.

There are two aspects of general anesthesia that involve inhalants: the induction phase and the maintenance phase. The induction phase is defined as the time period when

the patient initially receives anesthetic medication until they become unconscious. The maintenance phase is defined as the period of time from intubation until the surgery is complete and the anesthetic gases have been turned off.

Generally, sevoflurane is the inhalant used for induction because it is not a respiratory irritant and it has a less pungent odor. [3,4,12,14,15] It has been shown to be safe and highly efficacious.[3] It has a rapid uptake and elimination because of its low blood-gas partial coefficient.[3,4,14,15] Sevoflurane can be used as a maintenance gas as well, but due to its high cost, many anesthesiologists use other agents such as desflurane for the maintenance phase.

Desflurane is a relatively new gas that has been used in the maintenance phase but it has yet to be studied extensively in the pediatric population. Desflurane is not used to induce anesthesia because it is a respiratory irritant and it provokes complications like breath-holding and coughing, although there is no increase complications during maintenance and emergence.[4,5] It has the lowest blood-gas and tissue-blood solubility coefficients of any inhaled anesthetic, which allows rapid uptake and elimination leading to a more rapid recovery with less lingering effects.[5,12,14] These attributes make it a desirable anesthetic for the maintenance phase of general anesthesia. This is especially true in outpatient surgery centers where efficient patient management is crucial.

The emergence time from general anesthesia is defined as the end of the administration of anesthetic until extubation.[6] This aspect of anesthesia is important because reducing time in the operating room and reducing the amount of time the anesthesiologist has in direct patient care reduces the staff costs which are the principal

aspect of any anesthesia cost regimen.[6,8,13] It has been estimated that two-thirds of the total anesthetic expenditure is staff overhead.[7] Faster emergence time reduces the time between cases and increases efficiency, which is an aspect of every cost effective plan.[8] Economic awareness also has to consider patient satisfaction. One aspect of patient satisfaction is the behavior of the child post anesthesia.

A child's emergence behavior from general anesthesia is important to both the health care provider and the parent. Often times, patients are agitated upon emergence and during the initial recovery period. Emergence agitation occurs most frequently during the initial 10 minutes of recovery and has been defined as non-purposeful restlessness, agitation, thrashing, crying or moaning, disorientation and incoherence.[9,11,15]

There are limited studies that have examined the effectiveness of anesthetic protocols for reducing emergence agitation in children. These studies have reported mixed results pertaining to the anesthetic gas used and patients' emergence behavior. Cravero et al., reported sevoflurane as a maintenance inhalant produced agitation in 57% of patients while halothane produced agitation in 27% of patients.[3] In a study by Valley et al, emergence agitation occurred in 45% of patients maintained by desflurane and 20% of patients maintained with sevoflurane.[5] Ideally, levels of agitation and adverse events during the recovery period can be minimized with the appropriate selection of anesthetic gas.

This study had two specific aims. The first aim was to determine which maintenance gas resulted in a faster emergence from general anesthesia in the pediatric population. Since desflurane has the lowest blood-gas and tissue-blood solubility

coefficients of any inhaled anesthetic, we hypothesize that the children maintained with desflurane will emerge from anesthesia more quickly than those children maintained with sevoflurane. The second aim was to determine if children undergoing general anesthesia displayed different emergence behavior when the anesthetic maintenance gas was sevoflurane versus desflurane. We hypothesized that children receiving desflurane as a maintenance inhalant would have less emergence agitation compared to patients receiving sevoflurane.

Materials and Methods

Study design

This was a prospective study of children receiving dental treatment under general anesthesia. Children were randomly assigned to receive one of two anesthetic gases for the maintenance phase of anesthesia. The first group was maintained during general anesthesia with sevoflurane (MAC 1-1.5). The second group was maintained during general anesthesia with desflurane (MAC 1-1.5).

Patient Sample and Data Collection

The children enrolled in this study were patients whose caregivers had chosen general anesthesia for their child's dental treatment at the Virginia Commonwealth University School of Dentistry, Department of Pediatric Dentistry. The sample included 55 children ages 4-15 with non-contributory medical histories who were randomly assigned to one of two anesthetic gases for the maintenance phase of anesthesia. Prior to their general anesthesia appointment, all children had a complete oral exam and a treatment plan was created. The children were also required to have a completed history and physical examination by a physician clearing the patients for general anesthesia within the previous 30 days. All cases were completed on an outpatient basis in a dental office under the supervision of a dental anesthesiologist and a nurse anesthetist.

Anesthesia Protocol

The anesthesia protocol was the same for all cases except for the maintenance gas used during the surgery. The patients were induced with up to an 8% concentration of sevoflurane within 60% N_2O and 40% O_2. Once the airway was stable, an IV was placed and the patients were given 3-5 mcg/kg fentanyl, 1 mg/kg lidocaine, and up to 1-2 mg/kg propofol. Once the patient was intubated, the maintenance gas was turned on. The maintenance gas concentration of 3-5% was used to keep the patient anesthetized throughout the surgery. All maintenance inhalants were combined with 50% N_2O and 50% O_2. Some patients were given Decadron® (Dexamethasone, Merck & Co., Inc.) and/or Zofran® (Ondansetron Hydrochloride, GlaxoSmithKline) for their antiemetic properties during the maintenance phase of anesthesia. Some patients were also given Toradol® (Ketorolac, Roche Laboratories) for analgesia post operatively. The patient's blood pressure, heart rate, hemoglobin oxygen saturation and end tidal CO_2 were monitored throughout the procedure and documented at five-minute intervals until the patients were responsive and recovery completed. Upon completion of the dental treatment and removal of the throat pack, the anesthetic maintenance gas was turned off and the patients were given 100% oxygen. The patients were extubated once they were breathing spontaneously and had one of the following signs: eye opening or purposeful movements.

PAED Scale

Upon emergence the patient's behavior was evaluated using the validated Pediatric Anesthesia Emergence Delirium Scale (PAED).[4,9] An evaluator blinded to the maintenance

anesthetic gas completed evaluations at 5-minute intervals for 30 minutes beginning immediately upon extubation. It was the responsibility of the dentist performing the dental surgery to be the evaluator. Each evaluator was trained and calibrated in using the PAED instrument.

As Table 1 shows, the PAED Scale has five items: The first three are: (EC) The child makes eye contact with the caregiver, (PA) The child's actions are purposeful, and (AS) The child is aware of his/her surroundings. These items are scored: 4 = not at all, 3 = just a little, 2 = quite a bit, 1 = very much, 0 = extremely. The last two items are: (R) The child is restless, and (I) The child is inconsolable. These items are scored: 0 = not at all, 1 = just a little, 2 = quite a bit, 3 = very much, or 4 = extremely. Note that more desirable behavior/less delirium has lower scores while less desirable behaviors/ increased delirium have higher scores.

Control Variables

The following control variables were recorded: age, race, gender, weight, ASA (American Society of Anesthesiology) status, length of treatment, procedures completed, local anesthetic administered, drugs administered during anesthesia, medical history, administration of premedication, and extubation time.

Human Subjects

This study was conducted in compliance with the standard of care set forth by the American Academy of Pediatric Dentistry, the American Society of Anesthesiologist, and

the American Association of Nurse Anesthetists. The Virginia Commonwealth University Institutional Review Board approved this study for human subjects. All parents gave their written informed consent for their children to participate in the investigation.

Statistical Analysis

The independent variable in this study was the anesthetic gas (sevoflurane versus desflurane) used for the maintenance of general anesthesia. The principal outcome was the patient's PAED score across the emergence/recovery time period. Descriptive statistics were completed for patient characteristics such as gender, ASA status, the use of premedication, extractions performed, local anesthetic received, maintenance gas, age, weight, and length of procedure. Depending on the anesthesia provider, patients were given Decadron® for its anti-inflammatory and antiemetic properties, Zofran® for its antiemetic properties, and Toradol® for postoperative analgesia. Comparisons at baseline were performed using multi-way ANOVA and comparisons across time were done using a repeated-measures mixed-model that accounted for the within-subject correlation across time. All tests were done at the Alpha = .05 level of significance using SAS software.[10]

Results

The final study sample consisted of 55 subjects. As seen in Table 2, approximately half of the sampled patients were female and half were male. Patients ranged in age from 3 years and 1month to15 years and 11 months; with a median age of 6 years and 5 months. Subjects' weight's ranged from 15-61(kg) with a median of 23(kg). The majority of the patients (85%) were ASA class I, and over half of the patients (62%) received premedication prior to the induction of anesthesia. About 75% of the patients had extractions and therefore received local anesthesia. Treatment time varied between 45 minutes to 4 hours and 41 minutes with a median treatment time of 1 hour and 42 minutes. The distribution of the maintenance gas for the sample was 51% sevoflurane and 49% desflurane.

Medications that were administered during the procedures for pain and/or nausea have been summarized in Table 3. Three medications (Decadron®, Zofran®, Toradol®) were given to 65% of patients. 9% of the patients received Zofran® and Toradol®, while 7% received Decadron® alone. The combination of Decadron® and Toradol® was used by 2% and the combination of Decadron® and Zofran® by 16% of the patients.

Emergence Time

Overall, the mean emergence time was 14.14 minutes. The average emergence time for desflurane was 9.8 minutes (2.36); while the average for sevoflurane was 13.98 minutes (2.41). Patients who were given premedication had an emergence time of 15.43 minutes, while patients who were not given premedication had an emergence time of 8.34 minutes. The length of emergence in minutes was analyzed using multi-way ANOVA.

There was a statistical difference in emergence time due to both the maintenance gas ($p = 0.024$) and the use of premedication ($p = 0.001$). The average emergence time was 4.17 minutes longer with sevoflurane then desflurane (95% CI = 0.57-7.78). Emergence time was also 7.09 minutes longer when premedication was used (95% CI = 3.30-10.88). There was no difference in emergence time due to the use of a local anesthetic ($p > 0.5$) or pain/nausea medications Decadron® ($p > 0.8$), Zofran® ($p > 0.6$), or Toradol® ($p > 0.2$). These results are summarized in Table 4 and Figures 1-2.

Pediatric Anesthesia Emergence Delirium (PAED) Scale

Tables 5 and 6 summarize the mean PAED scale results across time. Generally, EC begins at “just a little” and by 30 minutes is at “very much”. PA begins between “quite a bit” and “just a little” and by 30 minutes is at “very much”. AS begins between “just a little” and “not at all” and by 30 minutes is “very much”. Restlessness and inconsolable is low overall, beginning at “just a little” and ending at “not at all”. The trend showed that patient’s agitation improved over the thirty minute time period.

To determine which anesthesia factors were significantly related to emergence behavior over time, a multi-way ANOVA was used. At extubation (time 0), PAED values and the following two-level factors were considered: premedication, local anesthetic, Decadron®, Zofran®, Toradol®, and maintenance gas. Table 7 summarizes the p-values for the multi-way ANOVAs indicating that only the use of Zofran® was a significant predictor of purposeful actions (PA p-value = 0.04).

Since Zofran® use appeared to impact emergence behavior at time 0, it was included in the repeated-measures mixed-model analysis of PAED behavior across the 7 time points (that is, from 0 up to 30 minutes in 5 minute increments). The following factors were included: maintenance gas, Zofran® use, time, time*gas, and time*gas*Zofran® (SAS Institute, version 9.1, Proc Mixed unstructured covariance matrix). The time*gas interaction effect was the test of interest. It indicated that the time trend is different in the two gas groups. Additionally, the three-way interaction tested whether the different time trend in the two gas groups is affected by Zofran® use. The results of the repeated-measures ANOVAs are shown in Table 8.

Eye contact (EC) improved across time ($p < .0001$) and did not vary depending upon gas or Zofran® use. The predicted mean EC score at each time point have been plotted in Table 9 and Figure 3. Purposeful actions (PA) improved across time ($p < .0001$) and did not vary depending upon gas (*p*s > 0.8). The predicted mean score for PA at each time point have been plotted in Table 10 and Figure 4. Note that there is a difference in purposeful actions due to Zofran® use ($p = 0.0103$). As seen in Figure 5, without Zofran® the purposeful action began at about 3.67 in both gas groups and improved to

approximately 1.5. With Zofran® the purposeful actions began at approximately 2.5 and improved to 0.83. Therefore, patients had more purposeful actions when they were given Zofran® in their IV. Awareness of surroundings (AS) improved across time as shown in Table 11 and Figure 6 ($p < .0001$) and did vary depending upon gas and Zofran® use as shown in Figure 7 (*p*-value < 0.05). Patients were more aware of their surroundings when they received Zofran® compared to patients who did not receive Zofran®. Patients who received Zofran® and desflurane were more aware of their surroundings then the patients who received Zofran® and sevoflurane. Because of the relationship with Zofran® use, it is more appropriate to inspect the relationship with a three-way interaction. (p-value = 0.0091). The predicted mean AS score at each time point for the three-way interaction of gas*time*Zofran® have been plotted in Figure 7. In patients who were not given Zofran®, there was no gas difference. In patients who were given Zofran®, there is a difference in emergence agitation between the two maintenance gas groups.

Restlessness (R) did not change over time and did not vary depending upon gas or Zofran® use. The predicted mean R score at each time point for each maintenance gas is shown in Table 12 and Figure 8. Also, inconsolability (I) did not change over time and did not vary depending upon gas or Zofran® use. The predicted mean I score for each maintenance gas over time is shown in Table 13 and Figure 9.

Discussion

In this study, desflurane as a maintenance inhalant allowed for a quicker emergence time from general anesthesia when compared to sevoflurane. This is due to the fact that desflurane has the lowest blood-gas and tissue-blood coefficient of any anesthetic inhalant.[5,12,14] From a case efficiency standpoint, knowing that desflurane produced a faster emergence time may be beneficial. The shorter the emergence time, the faster the room can be turned over and patient waiting time can be reduced.

Premedication is often used for the purpose of not upsetting the child upon separation from their caregiver and a smoother induction of anesthesia. This study found the use of premedication in patients lead to a longer emergence time, but did not seem to affect their emergence delirium/behaviors at the end of the case. This coincides with a study by Valley et al, which found the incidence of emergence agitation did not differ with midazolam premedication.[5] Local anesthetic, Decadron®, Toradol®, and Zofran® are used during anesthesia to reduce nausea and pain experienced by the patient during recovery. These medications were used according to the recommended dosages per weight. The use of Decadron® and Toradol® did not affect the patient's emergence time in this study.

As expected, the patient's delirium score as measured by the Pediatric Anesthesia Emergence Delirium instrument (PAED) were "more delirious" at the point of extubation

and became “less delirious” over the 30-minute time period. Similar to other studies, the patient’s emergence agitation subsided after the initial 10 minutes[11].

We found that there were no differences in emergence behavior when examining the maintenance inhalant used for the case. Neither desflurane nor sevoflurane alone produced more or less agitation upon emergence. We believe that anesthesia providers can base their choice of maintenance inhalant agent using other factors besides emergence delirium.

We then examined the impact of other drugs used during anesthesia on emergence delirium. We found that neither Toradol®, Decadron®, nor local anesthetic seemed to affect the patients PAED scores. Toradol® is an analgesic and expected to reduce the level of pain the patient experiences and therefore reduce their agitation. There were no statistical differences in PAED scores for patients who received Toradol® versus those that did not. Decadron® is a steroid that is used for its anti-inflammatory and antiemetic properties. The use of Decadron® did not affect the patient’s PAED scores. Local anesthetic may sometimes agitate patients if they are too young to understand the concept of “facial numbness”. Again, there was not a difference in PAED scores for patients with and without local anesthesia. These medications have a useful impact on the patient during general anesthesia, but they did not affect their emergence agitation or their PAED scores.

We found that Zofran® had a significant affect on the patients’ emergence behavior. Zofran® reduced emergence agitation by enabling the patients to be more aware of their surroundings and have more purposeful actions. When Zofran® was used, patients maintained with desflurane were even more aware of their surroundings upon emergence

compared to those maintained with sevoflurane. Therefore, Zofran® is beneficial from the patient's perspective, as they are less agitated upon emergence. Neither the maintenance gas nor the various medications used during the study affected the patient's eye contact, consolability, and restlessness during the thirty minutes of recovery. All three measures improved over time and were not altered by any medication.

Limitations

Many additional factors can affect a patient's emergence behavior including, but not limited to, fear of pain, type of patients seen in a pediatric dental residency, the procedure performed upon them, and even personality characteristics. Experiencing pain may be a significant factor in the manifestation of emergence agitation especially in the pediatric population. If the patient is not mature enough to verbalize their discomfort their behavior may be misinterpreted as emergence delirium. A patient's anxiety and reaction to being in an unfamiliar environment, the presence of strangers, or separation from their parents or caregivers may also be misconstrued as emergence agitation. According to Pryzbylo et al, agitation is increased due to sensory deprivation.[16] Sensory deprivation is unavoidable in a general anesthesia setting and may have impacted the results.

The classification of a patient's behavior according to the PAED scale is subjective. Having multiple evaluators may have affected the results due to the subjectivity inherent in the scale even though all evaluators were calibrated prior to data collection. Different anesthesia providers may have affected the results even though the protocol was the same for all patients. Some anesthesia personnel prefer to have the patient breathing on their

own, while others prefer to override the patient's breathing mechanism and use the ventilator. This may have affected how much gas the patient received and impact of the anesthesia for the individual patient physiologically.

This study shows that the use of desflurane as a maintenance inhalant is beneficial due to its rapid emergence time compared to sevoflurane. It is also interesting to note that the use of premedication produced a slower emergence from general anesthesia. This is beneficial for anesthesia providers who are interested in improving the turn over time of their caseload. The use of Zofran® during the case helped to reduce the patient's emergence agitation. This is beneficial for the recovery staff and parents. It is difficult for the parents to watch their child experience severe agitation. Anything that can be done to reduce this agitation is valuable.

Future studies that focus on reducing pediatric patient's emergence delirium are needed. It was interesting to see that Zofran® had such an impact on the patient's PAED scores. Further investigation by designing a study that used Zofran® as its independent variable with a standardized anesthesia protocol may be beneficial.

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Literature Cited

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Table 1: Pediatric Anesthesia Emergence Delirium (PAED) Scale[9]

Pediatric Anesthesia Emergence Delirium (PAED) Scale
1. The child makes eye contact with the caregiver 2. The child's actions are purposeful 3. The child is aware of his/her surroundings
4 = not at all 3 = just a little 2 = quite a bit 1 = very much 0 = extremely
1. The child is restless 2. The child is inconsolable
0 = not at all 1 = just a little 2 = quite a bit 3 = very much 4 = extremely

Table 2: Description of Patients

Characteristic	N	Percent
Gender		
Female	26	47
Male	29	53
ASA		
I	47	85
II	8	15
Premedication		
No	21	38
Yes	34	62
Extractions		
No	13	24
Yes	42	76
Local anesthetic		
No	12	22
Yes	43	78
Maintenance Gas		
Desflurane	27	49
Sevoflurane	28	51
	Mean	SD
Age (years)	7.40	3.28
Weight (KG)	27.36	12.33
Length of TX (hours)	1.95	0.97

Table 3: Medications Administered During General Anesthesia

Medication		N	Percent
Decadron®			
	No	5	9
	Yes	50	91
Zofran®			
	No	5	9
	Yes	50	91
Torodol®			
	No	13	24
	Yes	42	76

Table 4: Emergence Time

	Emergence Time (minutes)				
Groups	n	LS Mean	SE	95% CI	
Maintenance gas					
Desflurane	27	9.80	2.36	5.06	14.54
Sevoflurane	28	13.98	2.41	9.14	18.81
difference		4.17	1.79	0.57	7.78
Premedication					
No	21	8.34	2.61	3.09	13.59
Yes	34	15.43	2.17	11.07	19.80
difference		7.09	1.89	3.30	10.88

Table 5: PAED scale results at each time point

Time	0= extremely	1= very much	2=quite a bit	3=just a little	4=not at all	Mean	SD
	EC: The child makes eye contact with the caregiver						
0	3	4	3	18	25	3.09	1.16
5	8	5	6	16	20	2.64	1.43
10	11	11	11	15	7	1.93	1.35
15	18	9	11	12	5	1.58	1.38
20	22	12	10	8	3	1.24	1.28
25	25	13	12	3	2	0.98	1.11
30	30	14	7	2	2	0.76	1.05
	PA: The child's actions are purposeful						
0	4	5	14	15	15	2.60	1.21
5	7	7	12	17	12	2.36	1.31
10	12	10	16	7	10	1.87	1.39
15	15	13	11	8	8	1.65	1.40
20	21	12	7	10	5	1.38	1.39
25	24	15	8	4	4	1.07	1.25
30	28	15	5	3	4	0.91	1.22
	AS: The child is aware of his/her surroundings						
0	1	0	1	17	34	3.57	0.72
5	2	5	9	18	21	2.93	1.12
10	8	7	15	13	12	2.25	1.34
15	13	13	12	7	10	1.78	1.42
20	21	16	8	6	4	1.20	1.27
25	23	19	7	3	3	0.98	1.13
30	29	16	5	3	2	0.78	1.07
Time	0=not at all	1=just a little	2=quite a bit	3=very much	4= extremely	Mean	SD
	R: The child is restless						
0	21	15	8	6	3	1.15	1.23
5	26	14	8	7	0	0.93	1.07
10	29	13	9	4	0	0.78	0.98
15	33	15	7	0	0	0.53	0.72
20	39	11	5	0	0	0.38	0.65
25	38	14	3	0	0	0.36	0.59
30	41	10	2	2	0	0.36	0.73
	I: The child is inconsolable						
0	32	10	3	6	2	0.79	1.20
5	30	16	4	4	1	0.73	1.01
10	34	10	5	6	0	0.69	1.03
15	37	13	4	1	0	0.44	0.71
20	40	10	4	1	0	0.38	0.71
25	41	10	3	1	0	0.35	0.67
30	43	10	2	0	0	0.25	0.52

Table 6: PAED results at baseline and 30 minutes

Time	0= extremely	1=very much	2=quite a bit	3=just a little	4=not at all	Mean	SD
E: Eye Contact							
0	3	4	3	18	25	3.09	1.16
30	30	14	7	2	2	0.76	1.05
PA: The child's actions are purposeful							
0	4	5	14	15	15	2.60	1.21
30	28	15	5	3	4	0.91	1.22
AS: The child is aware of his/her surroundings							
0	1	0	1	17	34	3.57	0.72
30	29	16	5	3	2	0.78	1.07

Time	0=not at all	1=just a little	2=quite a bit	3=very much	4= extremely	Mean	SD
R: The child is restless							
0	21	15	8	6	3	1.15	1.23
30	41	10	2	2	0	0.36	0.73
I: The child is inconsolable							
0	32	10	3	6	2	0.79	1.20
30	43	10	2	0	0	0.25	0.52

Table 7: P-values for Multiway ANOVAs of the Baseline PAED

	PAED scale				
Effect	EC	PA	AS	R	I
PreMed (YN)	0.3671	0.4700	0.2720	0.9888	0.3933
Local (YN)	0.9580	0.5750	0.8474	0.8608	0.0639
Decadron® (YN	0.4354	0.7026	0.8627	0.1411	0.0644
Zofran® (YN)	0.2776	0.0413	0.2257	0.1231	0.2249
Torodol® (YN)	0.8554	0.2314	0.4882	0.9472	0.5073
Gas	0.1550	0.8836	0.2970	0.2821	0.2334

Table 8: Repeated-measures ANOVA of PAED scales

		PAED scale				
Effect	df	EC	PA	AS	R	I
Gas	1	0.9483	0.9446	0.6910	0.9812	0.9317
Zofran®	1	0.1484	0.0103	0.0451	0.1336	0.1149
Time	6	<.0001	<.0001	<.0001	0.5106	0.4378
Gas*Time	6	0.6111	0.9032	0.0015	0.3047	0.7415
Gas*Zofran®*Time	13	0.8354	0.8460	0.0091	0.6017	0.7081

Table 9: Eye Contact LS Means

Maintenance Gas		
Time	Desflurane	Sevoflurane
0	3.49	3.35
5	2.75	3.31
10	2.38	1.98
15	2.04	1.56
20	1.65	1.65
25	1.19	1.31
30	0.81	0.92

Table 10: Purposeful Actions LS Means

Maintenance Gas		
Time	Desflurane	Sevoflurane
0	2.98	3.21
5	2.85	3.19
10	2.42	2.48
15	2.19	2.10
20	2.02	1.96
25	1.54	1.58
30	1.31	1.02

Table 11: Awareness of Surroundings LS Means

Maintenance Gas		
Time	Desflurane	Sevoflurane
0	3.84	3.70
5	3.23	3.58
10	2.58	2.96
15	2.02	2.02
20	1.69	1.58
25	0.90	1.54
30	1.10	1.17

Table 12: Restlessness LS Means

Maintenance Gas		
Time	Desflurane	Sevoflurane
0	0.92	0.54
5	0.50	0.52
10	0.60	0.87
15	0.27	0.54
20	0.27	0.38
25	0.40	0.38
30	0.44	0.12

Table 13: Inconsolability LS Means

Maintenance Gas		
Time	Desflurane	Sevoflurane
0	0.64	0.33
5	0.46	0.35
10	0.42	0.81
15	0.25	0.46
20	0.29	0.37
25	0.25	0.13
30	0.13	0.15

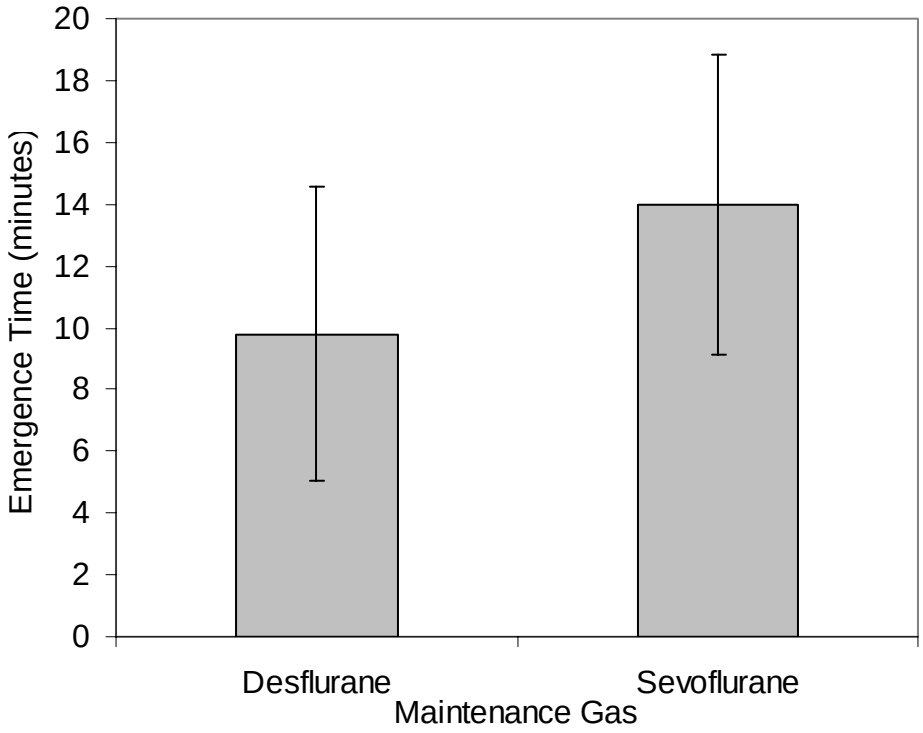


Figure 1: Emergence Time Difference for Maintenance Gas

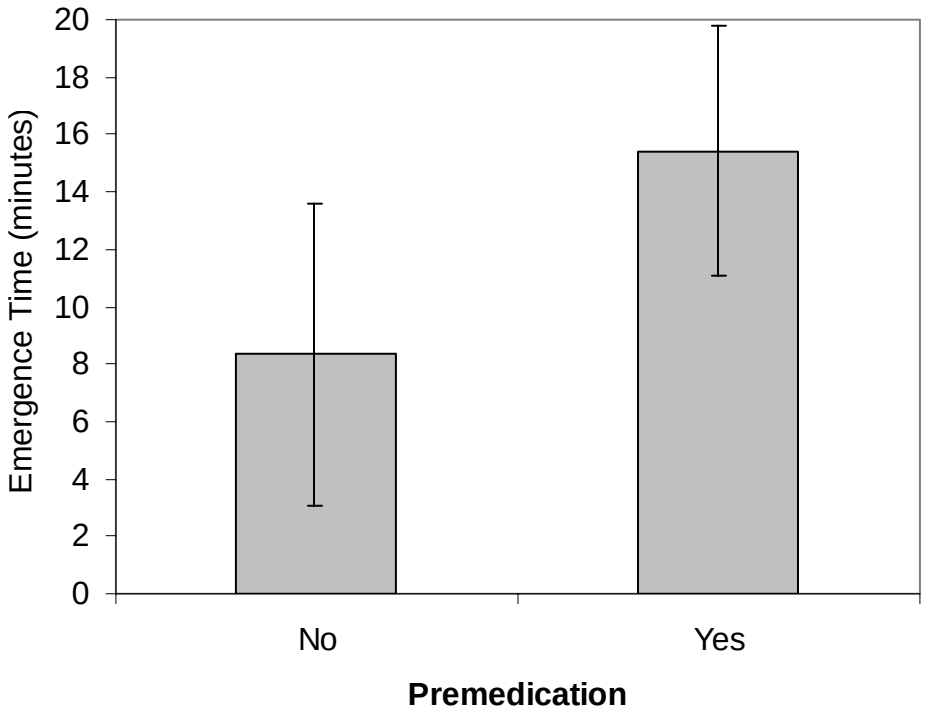


Figure 2: Emergence Time Difference for Premedication (Yes/No)

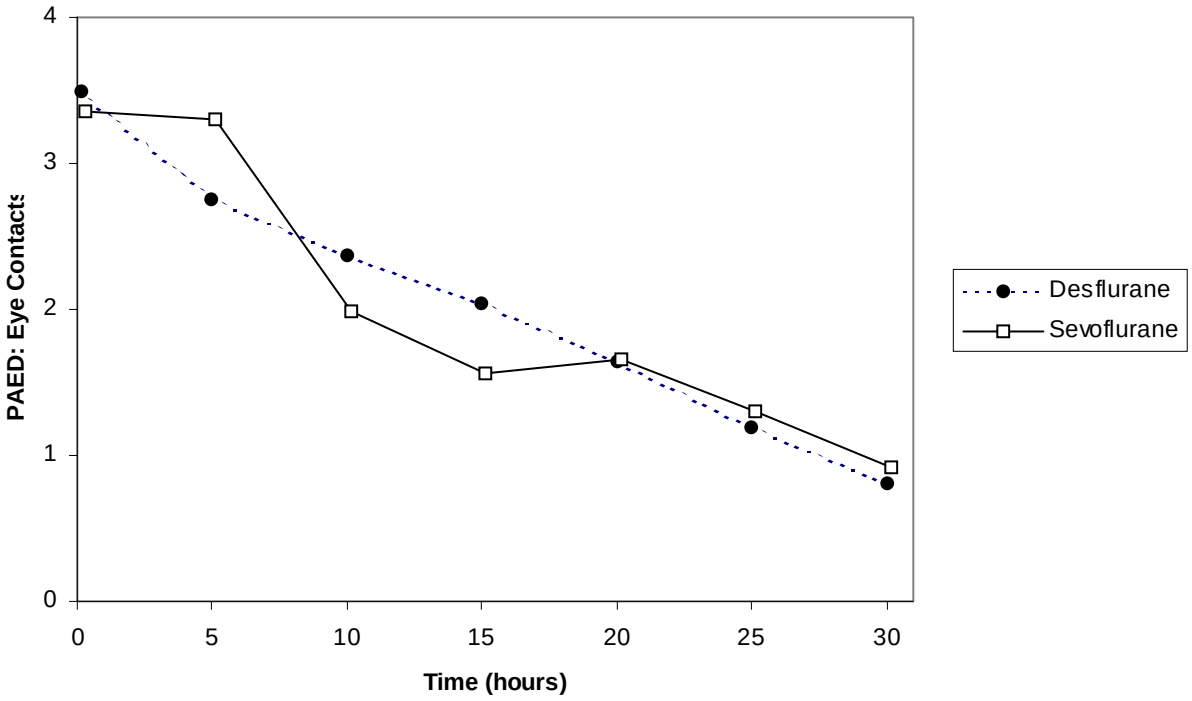
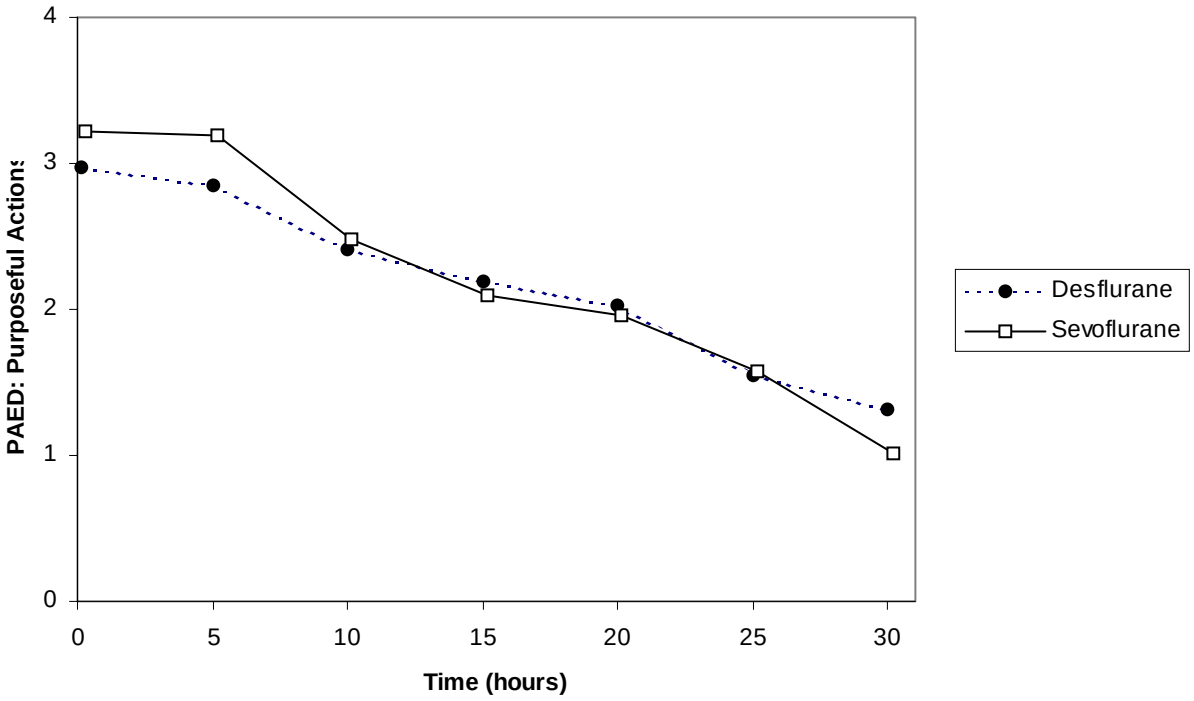


Figure 3: Eye Contact Across Time for the Maintenance Gas Groups



Figures 4: Purposeful Action Across Time for the Maintenance Gas Groups

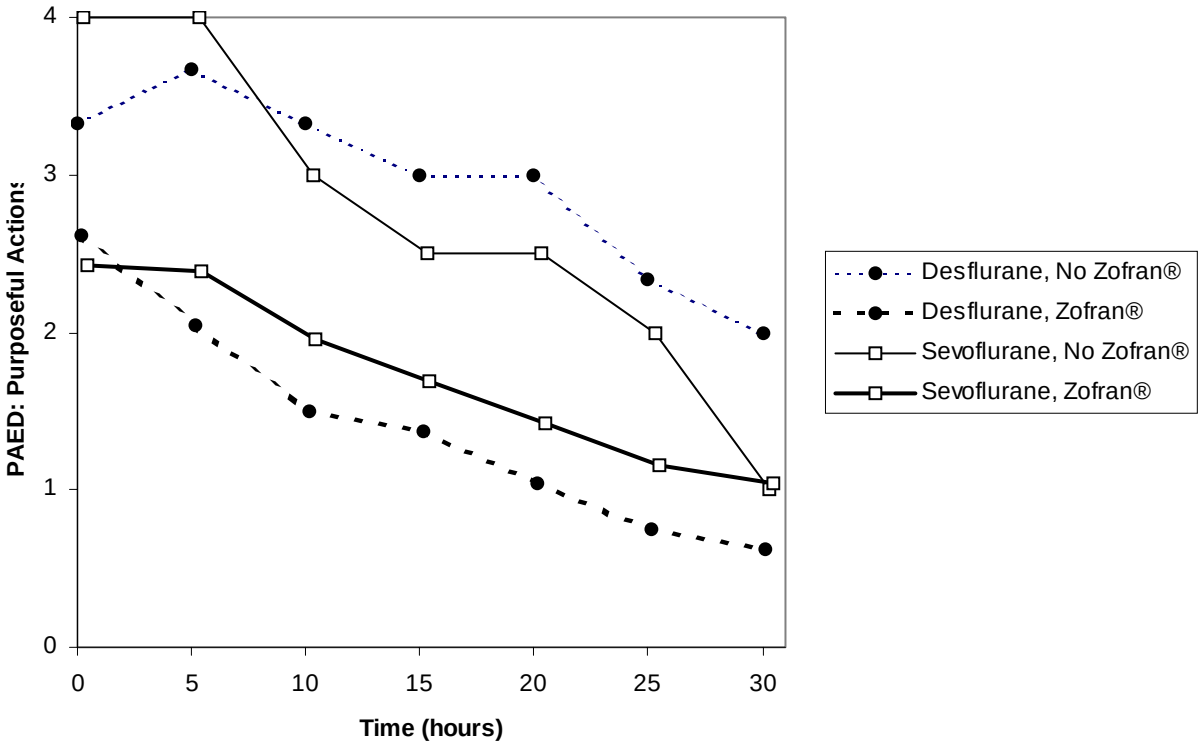


Figure 5: Purposeful Action with Maintenance Gas and Zofran® Use

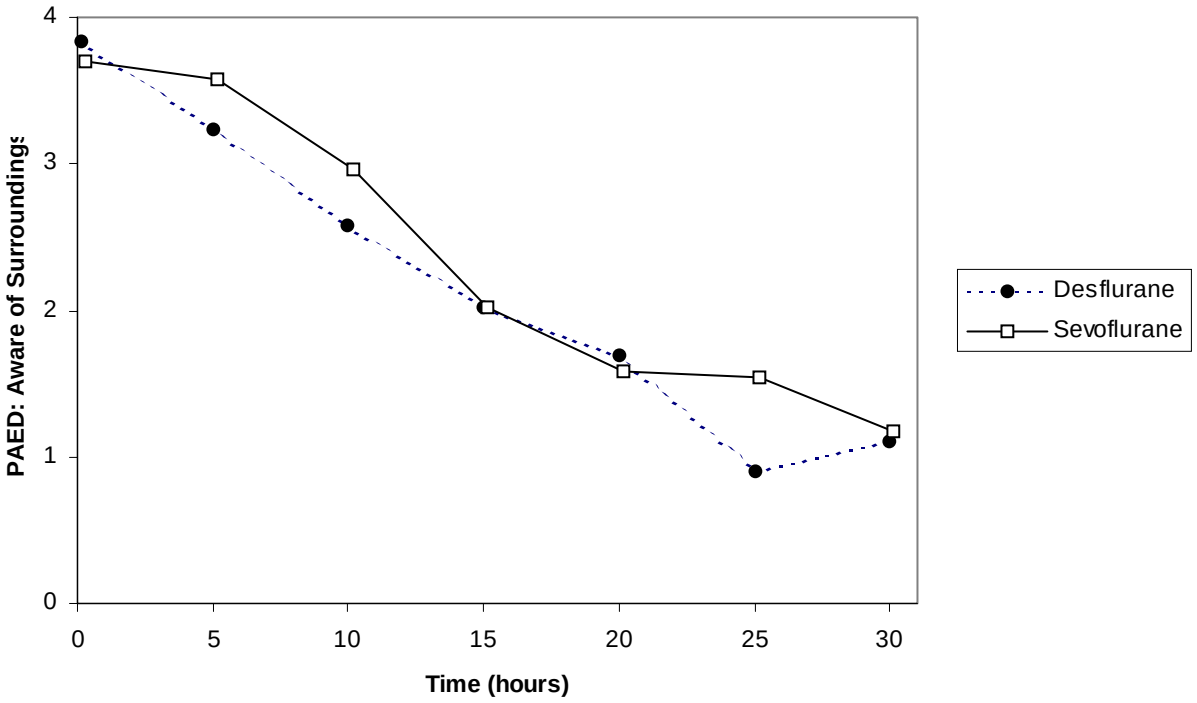


Figure 6: Awareness of Surroundings Across Time for the Maintenance Gas Groups

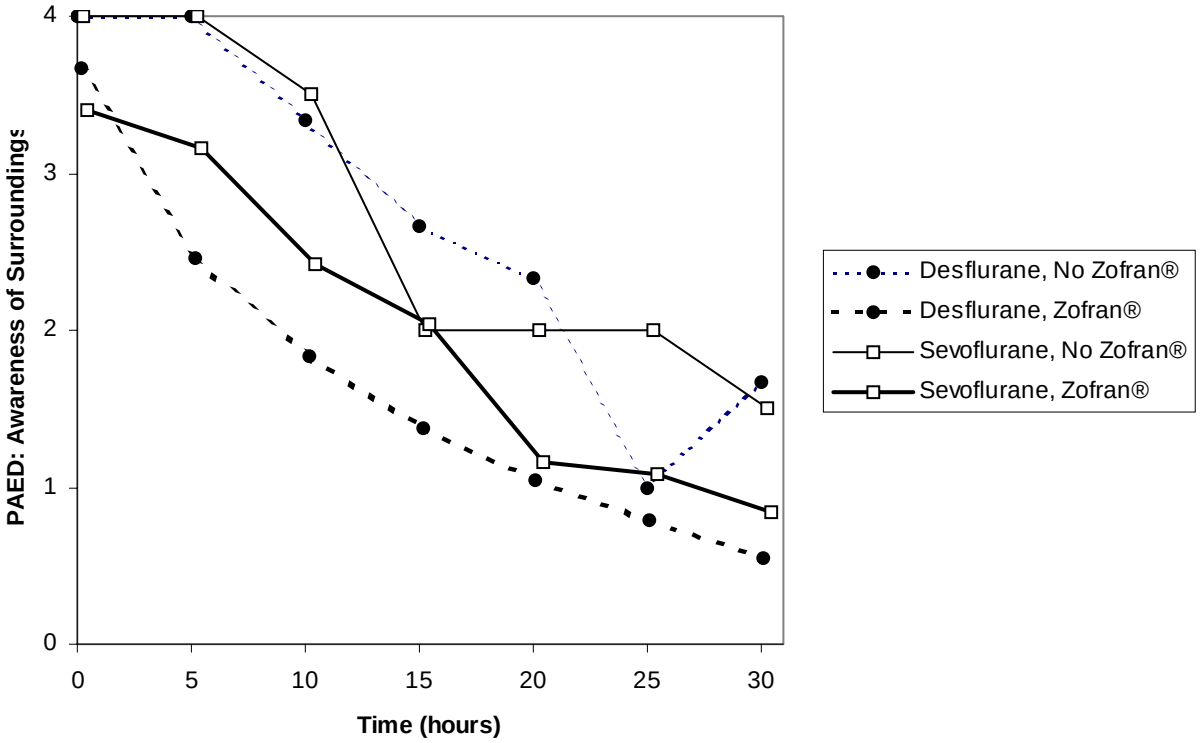


Figure 7: Awareness of Surroundings with Maintenance Gas and Zofran® Use

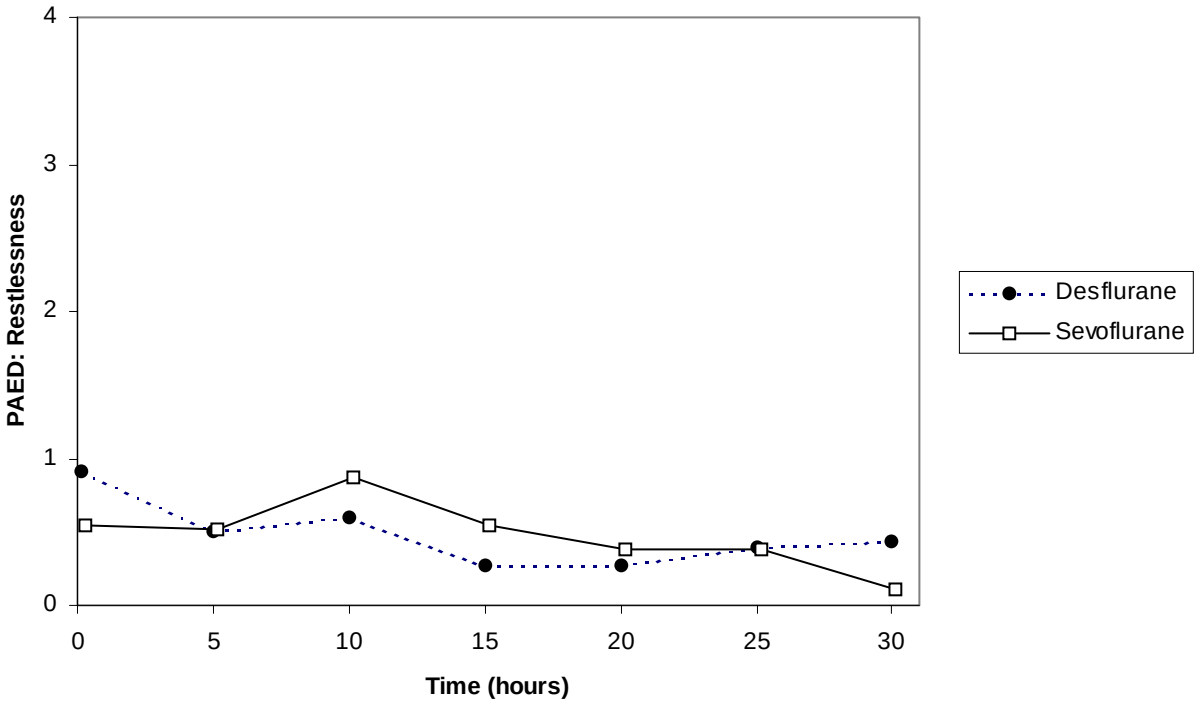


Figure 8: Restlessness Across Time for the Maintenance Gas Groups

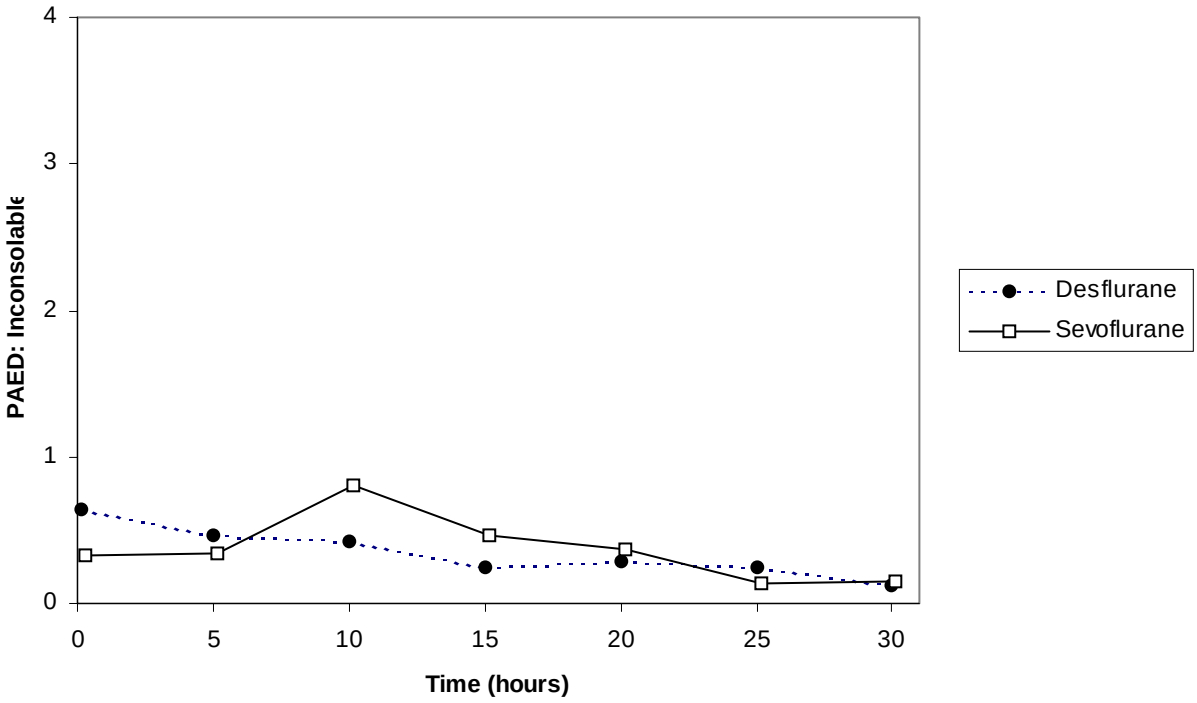


Figure 9: Inconsolability Across Time for the Maintenance Gas Groups

VITA

Carla J. LaLande was born April 25, 1979 in Omaha, NE. She graduated from Lake Havasu High School in 1997. She graduated Magna Cum Laude from the University of Nevada, Las Vegas in 2001 receiving a BA in Criminal Justice with minors in Biology and Chemistry. Dr. LaLande graduated Summa Cum Laude from the University of Nevada, Las Vegas, School of Dental Medicine in 2006. She was the recipient of the William S. Cramer Award of Excellence as a member of Omicron Kappa Upsilon.