Analysis of Oxygen Saturations Recorded During Dental Intravenous Sedations: A Retrospective Quality Assurance of 3500 Cases

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The death of a patient under sedation in New South Wales, Australia, in 2002 has again raised the question of the safety of dental sedation. This study sought answers to 2 questions: Can safe oxygen saturation levels ($\geq 94\%$) be consistently maintained by a single operator/sedationist? Does the additional use of propofol, in subanesthetic doses, increase the risk of exposure to hypoxemia? Three thousand five hundred cases generated between 1996 and 2006 were randomly examined and divided into 2 subcohorts: 1750 patients were sedated with midazolam and fentanyl, and 1750 patients received propofol, in subanesthetic increments, in addition to midazolam and fentanyl. Initial sedation was established using midazolam and fentanyl in both subcohorts. The second subcohort received propofol during times of noxious stimulation. Patient exposure to 2 or more oxygen desaturations below 94% was uncommon. The variables that were significantly associated with low saturations were age, gender, and weight. Neither the dose of midazolam nor the additional use of propofol was a significant risk factor. ASA classification (I or II) was not a determinant of risk. The data, within the limitations of the study, showed that a single operator/sedationist, supported by a well-trained team of nurses, can consistently maintain safe oxygen saturation levels. The additional use of propofol did not increase exposure to hypoxemia.

Key Words: Dental sedation; Safe oxygen saturation levels; Propofol.

Pain and anxiety management has always been an integral part of dentistry.¹ Dentists generally use local anesthetic for painful procedures. Some procedures, however, require greater levels of pain and anxiety management than can be provided by local anesthetics alone.² Intravenous drugs can cause a level of altered consciousness or sedation that provides a comfortable environment for otherwise noxious procedures.^{3,4} In-office sedation may negate the need to expose the patient to a general anesthetic, which requires a hospital

environment in Australia that may be hard to access and expensive for the uninsured.⁵

The question that this study sought to answer was whether an appropriately trained operator/sedationist, supported by a team of trained dental assistants, could maintain consistently normoxic (safe) oxygen saturation levels in the private practice dental setting.

The Faculty of Dentistry, University of Sydney, has offered a postgraduate Diploma in Clinical Dentistry (Conscious Sedation and Pain Management) since 1990. This 2-year, part-time program is a competency-based course that requires logged proof of successfully completed tasks. Candidates are given set tasks, including extensive training in the support of the unconscious human airway, the use of facemasks, Guedel airways, the use of laryngeal

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masks, and oral endotracheal intubation. Simulation training in the management of medical emergencies and crisis resource management is covered in great detail. Pharmacology, medical history taking, staff requirements, and training form part of the program. Two assignments and 1 dissertation need to be completed, and a minimum 14 weeks of in-hospital time is usually required over the 2-year period to satisfy the logbook requirements. Final examination includes both clinical and written examination and involves an external examiner, a specialist anesthesiologist, and a member of the faculty. Dr Viljoen has completed the Graduate Diploma in Clinical Dentistry as well as all 6 units of a training program provided by the Australian Society for the Advancement of Anaesthesia and Sedation in Dentistry (ASAASD), and received private mentoring with a specialist anesthesiologist over a 2-year period that included the supervised provision of intubated and nonintubated general anesthesia. Dr Viljoen has attended an annual Advanced Medical Simulation training program each year since graduating in 1994. This background is crucial for dentists to safely use propofol either alone or in combination with midazolam and fentanyl.

The Royal Australian College of Dental Surgeons and the Australian and New Zealand College of Anaesthetists have formulated guidelines for safe in-office dental sedation, which are outlined in policy document PS21 (RACDS/ANZCA PS21). The guidelines cover the following:

- Introduction: Conscious sedation is defined, as are potential risk factors.
- General principles: These cover medical history (ASA classification), consent, skills in airway management, avoidance of intended loss of consciousness, record of drugs administered, and use of local anesthesia to provide analgesia.
- Staffing: A third person, solely responsible for monitoring the patient, must be present. If general anesthesia is sought, an anesthesiologist must be present.
- Facilities: Room size, lighting, suction, availability of pulse oximetry, a defibrillator, emergency drugs, and positive pressure oxygen ventilating equipment are defined.
- Monitoring: Pulse oximetry must be used, and pulse rate, oxygen saturation, and blood pressure must be monitored and recorded.
- Oxygenation: Supplemental oxygen should be used because sedation can cause depression of respiratory drive.
- Drugs used for sedation: Commonly used sedation agents are mentioned as well as the fact that if anesthetic drugs are used, they must be in such low doses that unintended loss of consciousness is avoided.
- Training in sedation for dental procedures: The Graduate Diploma (University of Sydney) or equivalent is

defined as the minimum standard, whether the sedation is given by a dentist or a medical practitioner.

- Specialized equipment for nitrous oxide sedation: Oxygen flow rates, scavenging, the use of a nonreturn valve, servicing of equipment, and the need for an oxygen alarm are covered.
- Discharge: Recovery room equipment and staffing requirements, responsibility for discharge, and other anesthetic reference documents are discussed.
- Appendix I: The ASA classification system is defined.
- Appendix II: The emergency drugs required, including epinephrine, atropine, lidocaine, naloxone, flumazenil, and portable oxygen, are listed.

There are few references in the dental literature that specifically measured the safety of sedation in dentistry. Many studies show a clear link between use of sedation and risk of hypoxemia.^{6,7} However, no dental references were found in which the oxygen saturation levels recorded during sedations were used as a determinant of safety.

Perrott and colleagues⁸ reported on 34,191 patients who underwent oral surgical procedures using various anesthetic techniques. In this study, 5299 patients were treated using conscious sedation. The complication rate was 1.3%, although no details of the nature of the complications were given, other than that they were “minor and self-limiting.” The authors concluded that conscious sedation was safe and associated with a high level of patient satisfaction. Milgrom and colleagues⁹ reported on 207 sedations that tested the hypothesis that combined drug therapy (midazolam and fentanyl, or a double-blind placebo) results in significantly poorer safety but no difference in efficacy, compared with the single drug approach. They found that the addition of the narcotic resulted in apnea in 63% of cases versus 3% in the midazolam-only group. Interestingly, patients in the combination drug group were 4 times more likely to report an “excellent sedation” versus “good, fair, or poor” in the single drug group. Jastak and Peskin¹⁰ reported on 13 deaths under dental sedation between 1974 and 1989 in the USA. They examined the physical status of the patient, anesthetic technique used, probable cause of the morbid event, avoidability of occurrence, and contributing factors. They found that most patients were classified as ASA II or III with significant pre-existing conditions (obesity, cardiac disease, obstructive pulmonary disease). Hypoxemia was the most common cause of untoward events. Most events were determined to be avoidable. The authors felt that sedation risks increased significantly in patients with a score of greater than ASA I and with extremes of age.

Midazolam, fentanyl, and propofol all depress respiratory drive and increase risk of apnea and hypoxemia. Because in-office dental sedations should be carried out on reasonably healthy, ambulatory patients (ASA I and

II), one measure of safety is to examine the oxygen saturation levels recorded during sedations because it is hypoxemia that poses the greatest risk of morbidity or mortality to this otherwise healthy population.¹⁰

For the purposes of this study, safe oxygen saturation levels were defined as 94% and higher. The oxyhemoglobin desaturation curve is sigmoidal, and desaturation occurs very rapidly in the apneic or airway-obstructed patient once levels of 92% and lower are reached. Because rapid desaturation is an adverse event, in-office dental sedations should operate with a margin of safety. Modern pulse oximeters are accurate to within 2%,¹¹ and therefore a value of 94% was chosen as our minimum safe limit, because it provides a 2% safety factor to cover the possible “margin of error” of the pulse oximeter.

Much has been published about the medical use of intravenous sedation. Medical sedations differ, however, in many ways from dental sedations. Local anesthetic is often not used to cover painful aspects of a medical procedure, such as a colonoscopy, and may result in the use of higher doses of sedatives versus dental sedations, during which local anesthesia is almost always utilized. A wider range of ASA class and age are sedated, and treatment may be carried out in a hospital environment under the care of an anesthesiologist with full hospital backup. Therefore, the data obtained from medical sedations should not necessarily be extrapolated to the dental setting. Dentists need to generate their own in-office evidence base.

This study sought answers to 2 questions: (a) Were safe saturation levels consistently maintained (as defined above)? (b) Did the additional use of the general anesthetic induction agent propofol in subanesthetic doses increase the risk of exposure to 2 or more low-saturation events?

Answers to these questions will add to the evidence base about the safety of the single operator/seditionist plus a team of assistants; the risk that the use of propofol may or may not pose; and the effect of age, gender, weight, ASA class, and midazolam dose on the incidence of oxygen desaturation. These results should assist both dentists and anesthesiologists to form an evidence-based opinion on the safety of in-office dental sedation in Australia.

METHODOLOGY

The authors carried out a retrospective quality assurance analysis of 3500 intravenous dental sedation cases. This cohort was divided into 2 subcohorts. An initial retrospective pilot study of 100 sedations (50 received midazolam and fentanyl, and 50 received propofol in addition to the

midazolam and fentanyl) determined that 2 subcohorts of 1750 cases would give adequate power to the study.

Archived dental sedation records, which were generated by a single dentist in private practice between 1996 and 2006, were accessed, and, after data retrieval, the data were deidentified. Several different nurses recorded the data over the collection period. After preoperative measurement of vital signs, additional recordings were made during the sedation at 5-minute intervals. Data collection included age (18 and older), weight, gender, dose of midazolam, dose of fentanyl, and use of propofol (yes/no). The required number of cases for each subcohort (1750) was randomly selected from the data pool. All data were recorded on a standardized anesthetic chart.

The recordings of oxygen saturations via pulse oximetry were divided into 3 categories: less than 90% (acute hypoxemic crisis), between 90% and 93% (hypoxemia), and 94% and above (normoxemia). An adverse outcome (low-saturation events) was defined as 2 or more recordings of saturations less than 94% during the same sedation.

All sedations were used during oral surgical procedures. Patients were placed in a supine position, and supplemental oxygen was provided via a nasal hood at a rate of 4 L/min.^{12,13} A noninvasive monitor was used to provide pulse oximetry, capnography, electrocardiography and blood pressure monitoring.¹⁴ Intravenous access was established via a 23-gauge cannula, and normal saline was administered via intravenous infusion. Both subcohorts received midazolam first, which was administered slowly over a period of a few minutes to a dose of 2–5 mg and titrated until conscious sedation was established. Fentanyl was then administered slowly to a dose of 50–100 µg, based on patient response.¹⁵ A local anesthetic was then administered.

The first subcohort received additional titrated increments of midazolam during the procedure, if required to deepen the sedation, but propofol was not used. The second subcohort received propofol in addition to midazolam and fentanyl. Propofol was never given simultaneously with either midazolam or fentanyl and was only given after baseline sedation had been established. Propofol was given to this subcohort because of an operator-perceived need to briefly deepen the sedation to cover short periods of intense noxious stimulation (eg, elevation of a tooth),¹⁶ rather than using the slower acting, longer lasting drug midazolam, to deepen the sedation. Propofol was given in subanesthetic increments of 10–15 mg. Nitrous oxide was used during most sedations in the patient group 18 to 60 years of age. Most patients older than 60 years received supplemental oxygen only. Maximum concentration of nitrous oxide was 33% (a maximum of 2L nitrous oxide with 4L oxygen/min). If any difficulty was experienced in maintaining oxygen saturation levels of 94% and higher,

Table 1. Summary of the Number and Percentage of Oxygen Saturation Readings Recorded in Each of the Three Defined Saturation Categories

	<i>No Propofol</i>		<i>Propofol</i>		<i>Total Cohort</i>	
	No.	%	No.	%	No.	%
No. of SpO ₂ ≥94%	17,288	97.3	16,892	97.9	34,180	97.6
No. of SpO ₂ 90%–93%	480	2.7	350	2.03	830	2.37
No. of SpO ₂ <90%	17	0.095	8	0.046	25	0.07
Total for each category	17,785	100	17,250	100	35,035	100

the nitrous oxide was discontinued and the patient received 100% oxygen.

The term “single operator-sedationist” can be misleading in the context of how these procedures were carried out. The dental sedation team was composed of 4 people: the dentist-sedationist, 2 nurses assisting with the surgery (the first had the primary role of intraoral assistance, and the second assisted with head and airway support), a third nurse solely dedicated to monitoring the patient and outside the immediate surgical circle. All nurses rotated their roles after every case so that all were experienced and familiar with monitoring requirements and the need to maintain saturations at or higher than 94%. All nurses had current advanced cardiopulmonary resuscitation training and certification.

Vital signs and saturations were recorded at 5-minute intervals for a minimum of 45 minutes or for at least 30 minutes after cessation of the procedure. The pulse oximeter alarm was set at 94%. Capnography was used during all sedations.^{17,18} The capnograph probe was inserted into the nasal mask. Used in this manner, the sensor is in an open circuit (as opposed to a closed circuit with an intubated patient), and therefore the carbon dioxide concentrations that were recorded were not necessarily accurate. Nonetheless, a waveform is generated on the monitor with each exhalation, which provides a visual reference of effective ventilation.¹⁹ Because the circuit is open, a flat line on the capnograph trace is not necessarily an indication of apnea (it could be an indication of mouth breathing), but it was used as a prompt for the monitoring nurse to ask the patient to take a breath, even if saturation levels were 94% or higher. The use of a capnograph during intravenous sedation gave the sedation team warning that effective ventilation may not be occurring well before the pulse oximeter would begin to show signs of desaturation.²⁰ Readings of lower than 94% required the team to cease the operation until effective ventilation and safe oxygen saturation levels were re-established. All intraoperative desaturations were managed by ceasing the procedure, asking the patient to take a few deep breaths and only continuing with the procedure once the saturation levels were in the safe range. None of the patients in either cohort required positive pressure ventilation or any form of

advanced airway management (laryngeal mask, intubation) to recover from low-saturation readings.

RESULTS

The cohort of 3500 cases generated 35,035 individual oxygen saturation readings. In Table 1, these readings are presented in the 3 defined categories of oxygen saturation levels and are also expressed as a percentage for each category.

No record was made of whether desaturations were sequential in the 2 categories of 90% and higher because an adverse event is unlikely at these saturation levels. The records in the category of lower than 90% were examined, and none were sequential. The lowest recorded reading was 86%. Of the 25 desaturations recorded at lower than 90%, 4 cases occurred at the start of the procedure. This was a result of the respiratory depressive effect of the sedative drugs: all patients responded to the command “take a deep breath.” Eight desaturations occurred during the intraoperative phase, probably because of an imbalance between surgical demands and airway management. The majority of desaturations, 13, occurred at the end of the procedure when the patient was not receiving supplemental oxygen and was conscious and communicative. A Hudson face mask providing oxygen at 6 L/min was occasionally used during the recovery phase if desaturations were an issue.

Statistical analysis for each variable of interest was undertaken using (a) cross-tabulation of the variable by outcome: 2 or more saturation readings of lower than 94%; (b) associated chi-square test; (c) corresponding logistic regression analysis together with odds ratio and 95% CI.

For recording patient weight, the value was either self-reported or estimated to the nearest 5 kg. Gender-specific tertiles were used as categories that made it possible to create low, medium, and high weight groups in which the categories are all determined separately by gender, but the analysis of the effect of low, medium, and high weight on outcome permitted all the patients to be used, giving greater power to the statistical results. (There was no significant interaction between the effects of gender and weight tertile on outcome).

Table 2. Summary of the Difference Between Propofol and Nonpropofol Subcohorts

Variable	Category	Propofol Absent (%), (n =1750)	Propofol Present (%), (n =1750)	P Value*
Gender	Female	60.1	59.5	.705
	Male	39.9	40.5	
Age (y)	≤25	21.1	38.9	<.001
	26–35	15.8	25.0	
	36–45	26.9	19.3	
	>45	36.1	16.7	
Weight tertiles * (gender specific) (kg)	Low (≤60 female, ≤74 male)	38.2	39.5	.325
	Medium (61–68 female, 75–85 male)	32.2	33.2	
	High (≥69 female, ≥86 male)	29.6	27.3	
Midazolam dose (mg)	≤5	56.2	47.4	<.001
	>5 and ≤6	19.3	26.3	
	>6	24.5	26.3	
ASA class	I	92.1	96.0	<.001
	II	7.9	4.0	

* P value for chi-square test of association.

The gender-specific weight tertiles in kilograms were defined as follows: low = ≤60 female, ≤74 male; medium = 61–68 female, 75–85 male; high = ≥69 female, ≥86 male.

A difference between the 2 subcohorts (propofol = no; propofol = yes) was noted. Table 2 shows that younger, thinner, female patients in ASA class I were more likely to receive propofol. ASA II patients rarely received propofol. The exodontia patients predominantly underwent wisdom tooth removal and were mostly younger, and propofol was used to mask the noxious stimulation

experienced during tooth elevation. The second group underwent implant placement, and propofol was rarely required. Implants were needed mostly in the older patient group, who were also heavier.

A summary of the analysis using cross-tabulation of the variable by outcome (2 or more saturation readings <94%) is seen in Table 3.

The association of the variables of gender, age, gender-specific weight, dose of midazolam, ASA class, and use of propofol to the exposure of 2 or more low-saturation events is as follows:

Table 3. Table of Crude Associations Between the Variables and Outcome

Variable	Category	No.	% With Low-Saturation Events	Odds Ratio (95% CI)	P Value
Gender	Female*	2093	3.5	1	<.001
	Male	1407	9.0	2.71 (2.02–3.64)	
Age (y)	≤25*	1051	1.7	1	<.001‡
	26–35	715	3.6	2.17 (1.18–3.98)	
	36–45	809	5.6	3.38 (1.94–5.89)	
	>45	925	12.1	7.91 (4.77–13.12)	
Weight tertiles†	Low*	1360	4.3	1	<.001‡
	Medium	1144	5.1	1.20 (0.83–1.74)	
	High	996	8.5	2.10 (1.48–2.96)	
Midazolam dose (mg)	≤5*	1814	6.7	1	.031‡
	>5 and ≤6	798	4.1	0.60 (0.41–0.90)	
	>6	888	5.3	0.78 (0.55–1.11)	
ASA class	I*	3292	5.6	1	.065
	II	208	8.7	1.61 (0.97–2.67)	
Propofol	No*	1750	6.9	1	.005
	Yes	1750	4.6	0.66 (0.49–0.88)	

* Reference category.

† Unequal numbers in weight tertiles due to the “lumpy” nature of the self-reported or estimated weights.

‡ P values for test of overall homogeneity of risk if more than 2 levels for a factor.

Table 4. Multiple Logistic Regression Analysis of Lowsats and Putative Variables

Variables	P Value	Odds Ratio	95% CI for Odds Ratio	
			Lower	Upper
Gender (female)*	<.001	2.777	2.048	3.765
Age groups (y)	<.001†			
≤25*		1		
26–35	.035	1.937	1.048	3.581
36–50	<.001	2.938	1.662	5.196
>50	<.001	6.613	3.875	11.286
Weight tertiles (kg)	<.001†			
≤60 female, ≤74 male*		1		
61–68 female, 75–85 male	.796	0.950	0.646	1.398
>68 female, >85 male	.004	1.711	1.190	2.458
Midazolam group	.338†			
≤5 mg*		1		
>5, ≤6 mg	.178	0.752	0.497	1.138
>6 mg	.333	0.833	0.575	1.207
ASA class (I)*	.424	0.805	0.474	1.369
Propofol (no)*	.601	0.921	0.678	1.253

* Reference category.

† P value for test of overall homogeneity of risk if more than 2 levels for a factor.

- Gender: Males were almost 3 times more likely to experience low-saturation events than females.
- Age: The chance of experiencing low-saturation events increased with age. Using 25 years of age or less as the reference category, the 26- to 35-year-olds were about twice as likely to experience low-saturation events, the 36- to 45-year-olds were more than 3 times as likely, and the older than 45-year-olds were nearly 8 times more likely.
- Weight: There was no significant difference in the risk of low-saturation events between the low and medium gender-specific weight groups. The high weight group was nearly twice as likely as the low weight group to experience low-saturation events.
- Midazolam dose: An increase in the dose of midazolam was not associated with an increase in the chance of experiencing 3 or more low saturation events. Fifty percent of patients required 5 mg or less for their sedation procedure.
- ASA class: There was little difference in the risk of an ASA I or ASA II patient's experiencing low-saturation events.
- Propofol: The use of propofol in addition to midazolam and fentanyl was not a factor in the chance of a patient experiencing low-saturation events. The propofol group had 2% less exposure to low-saturation events. Based on these data, there is no evidence to suggest that the additional use of subanesthetic doses of propofol in our manner of administration increases the risk of exposing a patient to multiple low-saturation events.

Multiple logistic regression analysis of the data was also carried out. Table 4 shows a multiple logistic regression

model, adjusting for all variables. This did not show any indication of a significant propofol effect (odds ratio = 0.921, 95% CI 0.678–1.253, $P = .601$).

Backward stepwise variable selection using likelihood ratio testing was used to identify the independent predictors of low-saturation events. The independent predictors were gender, age group, and gender-specific weight tertile. The model including propofol and these independent predictors is shown in Table 5.

Gender, age, and weight are potential confounding variables, but the odds ratio associated with propofol use, after adjusting for the effects of these variables, remained not statistically significant and less than 1 (adjusted odds ratio = 0.936, 95% CI 0.688–1.272, $P = .671$).

DISCUSSION

The properly monitored patient cohort ASA class I and II should not experience an adverse event as a result of hypoxemia when sedated within the RACDS/ANZCA PS21 guidelines. The sedation technique used in this study provided spontaneous, effective ventilation with verbal communication maintained throughout the procedures.

Most sedative and anesthetic agents suppress respiratory drive, and therefore hypoxemia remains the one factor that, if not carefully monitored and controlled, has the potential to cause serious complications and even mortality. Propofol was developed as a general anesthetic induction agent and is a powerful respiratory depressant. It is therefore regarded by some as a drug suitable for use by anesthesiologists only. Clearly, low-dose propofol can be used by properly trained practitioners to provide

Table 5. Multiple Logistic Regression Model of Low-Saturation Events, Including Independent Predictors Identified by Backward Stepwise Elimination and Propofol

Variables	P Value	Odds Ratio	95% CI for Odds Ratio	
			Lower	Upper
Gender (female)*	<.001	2.705	2.000	3.658
Age groups (y)	<.001†			
≤25*		1		
26–35	.031	1.967	1.065	3.633
36–50	<.001	3.080	1.748	5.426
>50	<.001	6.977	4.143	11.750
Weight tertiles (kg)	.002†			
≤60 female, ≤74 male*		1		
61–68 female, 75–85 male	.675	0.921	0.628	1.352
>68 female, >85 male	.007	1.633	1.144	2.333
Propofol (no)*	.671	0.936	0.688	1.272

* Reference category.

† P value for test of overall homogeneity of risk if more than 2 levels for a factor.

conscious sedation.²¹ Propofol has other useful and beneficial effects when used in subanesthetic doses of 10–15 mg. At these low doses, propofol has antipruritic properties that may help control narcotic-induced itch.²² Propofol may also provide a degree of analgesia and has anticonvulsant and euphorogenic properties.²³ This study demonstrates that the addition of propofol did not result in an increased risk of recording 2 or more saturation levels of less than 94% during the sedation procedure. Of the 35,035 oxygen saturation recordings, only 25 were below 90% and none were sequential. Operating within the guidelines of PS21 for conscious sedation, which includes a significant amount of training and experience of the dentist in managing unconscious patients, the use of standard monitoring devices, including a capnographic trace to detect apnea, and a team of assistants with one dedicated to monitoring the patient might explain the very low number of saturation readings below 90%.

Risk factors for low saturations included gender, age, and weight. Males were almost 3 times more likely than females to experience low-saturation events at any given dose of midazolam, with or without propofol. The younger patient group had a very small chance (1.7%) of experiencing 2 or more desaturation events, but risk increased with increasing age. By 45 years of age, the chance increased to eightfold. This means that the older group of patients should receive 100% oxygen to reduce risk without the additional use of nitrous oxide.^{24–26} Weight only posed a risk factor for the “high” weight group in both genders, which doubled the risk.²⁷

Nonrisk factors included the dose of midazolam, ASA classification (I or II), and use of propofol. The ASA classification was developed as a means of determining anesthetic risk. Interestingly, these results show that ASA classification (I or II), when used to determine the risk of experiencing low-saturation events during dental sedation,

was not predictive. Rather, age, weight, and gender were factors that should be considered in assessing the risk of developing hypoxemia. Propofol can have a profound short-term depressive effect on respiratory drive. It is therefore interesting to note that the propofol subcohort did not have a higher incidence of having low-saturation events. This may be due in part to the lower dose of midazolam required when propofol was used, the use of supplemental oxygen, and careful patient monitoring, including the use of capnography.²⁸

The limitation of this study is that one dentist generated all the data; it would be useful for other dental sedationists with similar training to undertake similar audits that would add to the evidence base. Retrospective studies and case control studies are also relatively low in the hierarchy of strength of evidence.

Within the limitations of this study, the data support that a single, well-trained operator/sedationist, working within the RACDS/ANZCA document PS21 guidelines and supported by a team of experienced nurses, can consistently maintain safe oxygen saturation levels regardless of age, gender, gender-specific weight, dose of midazolam, ASA class (I or II), or additional use of propofol.

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