




Assessment of Nitrous Oxide Inhalation Sedation Module in Kuwait: A Survey on Undergraduate Dental Training Curriculum

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Introduction: The use of nitrous oxide/oxygen (N₂O/O₂) inhalation sedation in dentistry has increased worldwide. This study aimed to evaluate the nitrous oxide/oxygen (N₂O/O₂) inhalation sedation undergraduate teaching curriculum at Kuwait University Faculty of Dentistry.

Methods: A cross-sectional survey involving dental students in their clinical years (5th, 6th, and 7th years) at Kuwait University Faculty of Dentistry was conducted. Participation was voluntary and anonymous. The Likert scale-based survey comprised 17 statements that assessed various aspects of N₂O/O₂ inhalation sedation in dental procedures. Continuous data variables were compared among different groups using one-way analysis of variance (ANOVA). Categorical data variables were compared using either the Chi-squared test or Fisher's exact test.

Results: Fifty-six students participated in this survey-based study. All students attended an approximately equal number of practical hands-on-training sessions, with a mean of 1.7 (± 1.1) sessions (p = 0.813). Most students expressed confidence in administering N₂O/O₂ inhalation sedation with an insignificant difference between each group (p = 0.276). However, low confidence level was observed in certain intraoperative and postoperative management aspects of providing N₂O/O₂ to patients.

Conclusion: This study indicated that the teaching curriculum regarding N₂O/O₂ inhalation sedation should be regularly evaluated. The quality of students' educational pathways should also be assessed through surveys to improve and develop dental school curricula to the highest standard levels.

Keywords: nitrous oxide, inhalation sedation, conscious sedation, dental education, curriculum revision

Introduction

Enhancing and improving the dental education through constant evaluation and assessment of dental curricula is the keystone of the accredited dental profession standards.¹ Comprehensive theoretical and clinical teaching practices have a major impact on the strength of a dental school curriculum, hence the expected level of their dental graduate's knowledge, skills, and competency. Therefore, dental students are continuously assessed and evaluated throughout their training period not only to ensure meeting the set standard but also to inculcate safe dental practices within a positive academic environment.²

Practicing dentistry has long been associated with fear, anxiety, and pain, which may contribute to dental treatment avoidance.^{3–5} These barriers can be well

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controlled through proper management techniques. Conscious sedation is one of the pharmacological intervention techniques that can be provided to manage pain and anxiety in patients undergoing dental treatments.^{4,6} It is defined as a controlled state of depressed consciousness while retaining the patient's protective reflexes and patent airways that permits appropriate patient's response to physical and verbal stimuli.⁷ The administration of conscious sedation medications includes inhalation, intravenous, oral and transmucosal routes.⁸ The use of nitrous oxide/oxygen (N₂O/O₂) inhalation sedation is commonly taught in many dental schools worldwide as a safe and effective technique to manage anxious patients.^{9–11}

Nitrous oxide has both sedative and analgesic properties with the fastest onset among other inhalation agents due to its very low solubility that leads to rapid equilibration.¹² The nitrous oxide saturation peak could be reached within five minutes, whereas 90% elimination in ten minutes.¹³ It is a non-invasive and relatively easy technique to perform and is well tolerated by patients as it is odorless to sweet-smelling and non-irritating to the tissues.¹² However, the use of N₂O/O₂ inhalation sedation is contraindicated in patients with upper airway obstruction, pregnancy, vitamin B₁₂ deficiency, and some psychological and/or cognitive disturbances or complex medical conditions.^{12,13} The major disadvantage associated with N₂O/O₂ inhalation sedation is the nitrous oxide pollution, which can be prevented by a scavenging system. Without a proper scavenging system, nitrous oxide may accumulate and lead to vitamin B₁₂ deficiency and demyelination syndromes.¹³

In Kuwait, administering N₂O/O₂ inhalation sedation was officially approved and regulated in 2010; dentists were unable to provide such service prior to that date in their dental clinics even with trained practitioners. 14 Kuwait laws and regulation for the use of N₂O/O₂ inhalation sedation require that providers complete a training consisting of a minimum of three hands-on cases and a minimum of 18 hours of dictated teaching. The laws also require that any licensed dentist must be certified with basic life support (BLS) and advanced cardiac life support (ACLS).

Given the increased popularity of N₂O/O₂ inhalation sedation among both patients and dentists worldwide, and particularly in Kuwait, it was inevitable to integrate a specific module dedicated to N₂O/O₂ inhalation sedation into Kuwait University Faculty of Dentistry educational curriculum of dental anesthesia in 2012.^{14–20} The N₂O/O₂

module includes eight hours of didactic training followed by a total of 22 hours of clinical hands-on training. The didactic training includes seven different topics that cover patient selections, pharmacology, administration, patient monitoring, patient discharge, safety, and medical emergencies. However, the hands-on clinical training comprises four cases on real patients in which the students must complete and apply the knowledge gained in their didactic topics. The module is provided to all students in their fifth year as it is a mandatory requirement to successfully complete as it is one of the graduation requirements. Upon completing the course and passing the module successfully through a competency test, the students are also required to administer N₂O/O₂ to patients who meet the relevant criteria and manage any concomitant complications accordingly. The competency test comprises a knowledge test that the students must pass with an 85% overall mark and a managing full case where they must provide nitrous oxide to a patient.

It is important to state that studying dentistry at Kuwait University normally takes 7 years, which includes the first four years together with the medical students to complete a Bachelor of Medical Sciences (B.Med.Sc.), followed by three clinical dental years to be awarded with the degree of Doctor of Dental Medicine (D.M.D.). In addition, all students in their clinical years have a valid basic life support training.

Therefore, we aimed in this study to evaluate the alacrity and self-reported confidence levels of dental students in their clinical years (fifth, sixth, and seventh years) in administering N₂O/O₂ inhalation sedation to their patients.

Methods

The study protocol was approved by the Ethics Committee of Kuwait University Health Sciences Center, and the study complied with the principles of Declaration of Helsinki. Between June 1st and July 1st, 2020, we conducted a cross-sectional survey involving fifth-, sixth-, and seventh-year dental students at Kuwait University Faculty of Dentistry. The survey was distributed electronically to eligible students using Google Forms. All participants provided informed consent to participate in the survey. The eligibility criteria to participate were successful completion of the N₂O/O₂ theoretical teaching module and completion of the N₂O/O₂ clinical module. The survey comprised 17 statements based on the knowledge and self-confidence of administering N₂O/O₂ sedation to patients including its preoperative,

Table 1 Summary of Demographic Characteristics

Demographic Characteristic	Total	Fifth Year (n=18)	Sixth Year (n=20)	Seventh Year (n=18)
Age, mean \pm SD, years	23.5 (\pm 1.2)	22.1 (\pm 0.3)	23.5 (\pm 0.6)	24.8 (\pm 0.4)
Gender, n (%)				
Male	1 (1.8)	0	1 (5)	0
Female	55 (98.2)	18 (100)	19 (95)	18 (100)
Hand-on Training Sessions, mean \pm SD	1.7 (\pm 1.1)	1.6 (\pm 0.7)	1.7 (\pm 0.8)	1.8 (\pm 1.6)

intraoperative, and postoperative managements. After completing the survey, the responses were analyzed accordingly.

Statistical Analysis

Statistical analysis was performed using SPSS Statistics 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Macintosh, Version 23.0. Armonk, NY: IBM Corp.). Likert data were presented as counts and percentages. Responses were scored on a scale of 1–5 with “Strong Agreement = 1” and “Strong Disagreement = 5.” These values were also used as continuous variables to present a mean value for each group and each statement. Continuous data variables were compared between the fifth-, sixth-, and seventh-year students using a one-way analysis of variance (ANOVA). Categorical data variables were compared using the Chi-squared test or Fisher’s exact test (when cell counts <5). A p -value <0.05 was considered statistically significant.

Results

Fifty-six out of sixty-six (response rate of 84.84%) dental students completed the survey with a roughly equal distribution among the fifth-year ($n = 18$), sixth-year ($n = 20$), and seventh-year ($n = 18$) students. The mean age of the respondents was 23.5 (\pm 1.2) years. Of the 56 students, 55 (98.2%) were female (Table 1). There was no significant difference in the number of practical hands-on training sessions attended by the students from each year, with a mean of 1.7 (\pm 1.1) sessions ($p = 0.813$). Figure 1 and Table 2 summarize the Likert responses based on each category. Compared with the sixth- and seventh-year students, fifth-year students expressed the highest level of agreement for every statement.

Most students expressed confidence in administering N_2O/O_2 , and the difference amongst the groups was insignificant ($p = 0.276$). Compared with the sixth- and seventh-year students, fifth-year students exhibited higher

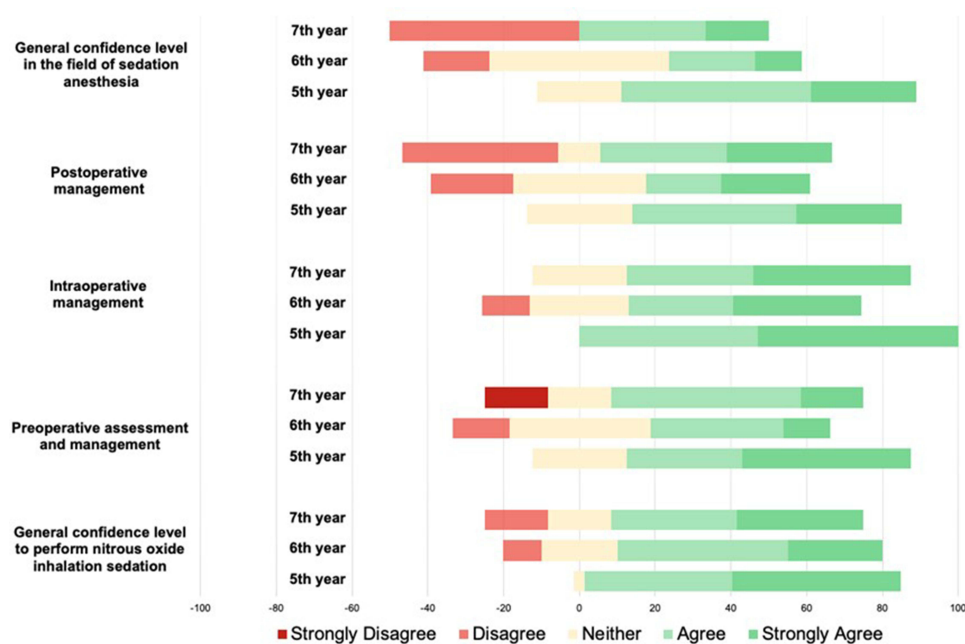
**Figure 1** Summary of participant responses.

Table 2 Survey Responses

Statement	Year	Strongly Agree, n (%)	Agree, n (%)	Neither Agree nor Disagree, n (%)	Disagree, n (%)	Strongly Disagree, n (%)	Mean ± SD	p-value
General confidence level to perform nitrous oxide/oxygen (N₂O/O₂) inhalation sedation								
I have been properly trained/educated and confident in the field of N ₂ O/O ₂ inhalation sedation.	5th year	8 (44.4)	7 (38.9)	3 (16.7)	0	0	1.72 (± 0.75)	0.276
	6th year	5 (25)	9 (45)	4 (20)	2 (10)	0	2.15 (± 0.93)	
	7th year	6 (33.3)	6 (33.3)	3 (16.7)	3 (16.7)	0	2.17 (± 1.10)	
Preoperative assessment and management								
I have been properly trained/educated and confident to select the proper patient for N ₂ O/O ₂ sedation.	5th year	12 (66.7)	3 (16.7)	3 (16.7)	0	0	1.50 (± 0.79)	0.021
	6th year	3 (15)	8 (40)	7 (35)	2 (10)	0	2.40 (± 0.88)	
	7th year	6 (33.3)	6 (33.3)	3 (16.7)	0	3 (16.7)	2.33 (± 1.41)	
I have been properly trained/educated and confident to select the level of sedation needed.	5th year	4 (22.2)	8 (44.4)	6 (33.3)	0	0	2.11 (± 0.76)	0.118
	6th year	2 (10)	6 (30)	8 (40)	4 (20)	0	2.70 (± 0.92)	
	7th year	0	12 (66.7)	3 (16.7)	0	3 (16.7)	2.67 (± 1.14)	
Intraoperative management								
I have been properly trained/educated and confident to position the patient in the proper position when providing N ₂ O/O ₂ to patients.	5th year	8 (44.4)	10 (55.6)	0	0	0	1.56 (± 0.51)	0.115
	6th year	5 (25)	11 (55)	4 (20)	0	0	1.95 (± 0.69)	
	7th year	6 (33.3)	6 (33.3)	6 (33.3)	0	0	2.00 (± 0.84)	
I have been properly trained/educated and confident to place the needed monitors on the patients before providing N ₂ O/O ₂ sedation to patients.	5th year	10 (55.6)	8 (44.4)	0	0	0	1.44 (± 0.51)	0.022
	6th year	7 (35)	4 (20)	5 (25)	4 (20)	0	2.30 (± 1.17)	
	7th year	9 (50)	3 (16.7)	6 (33.3)	0	0	1.83 (± 0.92)	
I have been properly trained/educated and trained to interpret the reading form the monitors attached to the patients.	5th year	10 (55.6)	8 (44.4)	0	0	0	1.44 (± 0.51)	0.002
	6th year	6 (30)	5 (25)	7 (35)	2 (10)	0	2.25 (± 1.02)	
	7th year	9 (50)	9 (50)	0	0	0	1.50 (± 0.51)	
I have been properly trained/educated and confident to position the equipment safely on the patient and in the proper position when providing N ₂ O/O ₂ to patients.	5th year	10 (55.6)	8 (44.4)	0	0	0	1.44 (± 0.51)	0.044
	6th year	9 (45)	2 (10)	5 (25)	4 (20)	0	2.20 (± 1.24)	
	7th year	6 (33.3)	6 (33.3)	6 (33.3)	0	0	2.00 (± 0.84)	
Postoperative management								
I have been properly trained/educated and confident to manage post sedation nausea and vomiting if happened.	5th year	3 (16.7)	7 (38.9)	8 (44.4)	0	0	2.28 (± 0.75)	0.001
	6th year	2 (10)	2 (10)	9 (45)	7 (35)	0	3.05 (± 0.94)	
	7th year	0	3 (16.7)	6 (33.3)	9 (90)	0	3.33 (± 0.77)	

I have been properly trained/educated and confident to evaluate the patient for discharge after N ₂ O/O ₂ sedation.	5th year	5 (27.8)	8 (44.4)	5 (27.8)	0	0	0	2.00 (± 0.77)	0.470
	6th year	7 (35)	3 (15)	6 (30)	4 (20)	0	0	2.35 (± 1.18)	
	7th year	6 (33.3)	9 (50)	0	3 (16.7)	0	0	2.00 (± 1.03)	
I have been properly trained/educated and confident to provide post sedation instruction to patients.	5th year	7 (38.9)	9 (50)	2 (11.1)	0	0	0	1.72 (± 0.67)	0.189
	6th year	5 (25)	7 (35)	6 (30)	2 (10)	0	0	2.25 (± 0.97)	
	7th year	9 (50)	6 (33.3)	0	3 (16.7)	0	0	1.83 (± 1.10)	
General confidence level in the field of sedation anesthesia									
I have been properly trained/educated and confident in the field of sedation anesthesia.	5th year	5 (27.8)	13 (72.2)	0	0	0	0	1.72 (± 0.46)	0.039
	6th year	5 (25)	2 (10)	10 (50)	3 (15)	0	0	2.55 (± 1.05)	
	7th year	6 (33.3)	6 (33.3)	0	6 (33.3)	0	0	2.33 (± 1.28)	
I perceive a need from your dental patient population for sedation services.	5th year	5 (27.8)	5 (27.8)	8 (44.4)	0	0	0	2.17 (± 0.86)	0.001
	6th year	0	7 (35)	9 (45)	4 (20)	0	0	2.85 (± 0.75)	
	7th year	0	6 (33.3)	0	12 (66.7)	0	0	3.33 (± 0.97)	

confidence in selecting the proper N₂O/O₂ sedation ($p = 0.021$). However, all students demonstrated neutral to negative confidence in selecting the N₂O/O₂ level, with the fifth-year students showing slight confidence. Overall, all students expressed confidence regarding statements related to intraoperative management. However, sixth-year students were the least confident in placing monitors on patients ($p = 0.022$), interpreting the monitors ($p = 0.002$), and proper positioning of equipment ($p = 0.044$). Post-operatively, seventh-year students expressed a lack of confidence in managing nausea and vomiting ($p = 0.001$). There was an insignificant difference between the groups in terms of evaluating patients for discharge post-sedation and providing the patients with post-sedation instructions. Regarding anesthesia, fifth-year students were significantly more confident in their training ($p = 0.039$). Approximately two-thirds of seventh-year students perceived that patients did not need sedation.

Discussion

The quality of the teaching curriculum at any dental school is reflected by the clinical and theoretical competencies of its graduates, as well as the ability of the students to meet the defined educational objectives and milestones. The students at the same time are required to exhibit a certain level of competency to ensure the level of knowledge and safe practice after graduation. Nevertheless, updating the dental curricula frequently to meet the emerging dental advancement and the cutting-edge technologies should be clearly emphasized to reach modern dental students' needs and expectations.^{21,22}

In 2012, the Faculty of Dentistry at Kuwait University introduced the N₂O/O₂ clinical module into its curriculum, involving more than 30 hours of theoretical and clinical training. This study aimed to assess the knowledge and confidence of dental students in administering N₂O/O₂ inhalation sedation to patients using a Likert scale-based survey to assess if the curriculum provided met the training intended. The N₂O/O₂ sedation module at Kuwait University Faculty of Dentistry adapted a mixture of didactic and experiential learning approach, which is similar to the well-known teaching model of dental local anesthesia administration.^{23,24} A recent study showed that didactic learning alone was inadequate to completely prepare dental students to administer N₂O/O₂ sedation for patient care, strongly suggesting hands-on exercises to be incorporated into the N₂O/O₂ inhalation sedation curriculum.²² As a result, all students participating in the

current study expressed competence and confidence regarding their ability to provide N₂O/O₂ sedation to their patients. However, analyzing the data for each year and its comparison with other years revealed some differences in terms of patient selection, level of sedation, N₂O/O₂ sedation monitoring, and postoperative management.

Fifth-year students demonstrated a lack of knowledge while selecting patients that needed N₂O/O₂ sedation along with the level of sedation to be administered, which could be attributed to the lack of clinical experience compared with the sixth- and seventh-year students. Interestingly, sixth-year students expressed a lack of experience and training in monitoring N₂O/O₂ sedation in patients. However, fifth- and seventh-year students expressed more confidence in this aspect, which could be partially attributed to knowledge retention. Students who received their N₂O/O₂ sedation training at the beginning of their fifth year showed a higher level of knowledge retention. Additionally, seventh-year dental students had more clinical experience and sedation training; thus, explaining the higher knowledge retention. Surprisingly, the evidence of retention of knowledge with progression to more senior years is controversial, in which the current study supports its controversy. Several studies showed a marked decline in knowledge retention with increasing student seniority,^{25,26} whereas another study showed the opposite trend in which junior students scored lowest among their peers in more senior years.²⁷ On the other hand, it has been evident that the most common side effects of N₂O/O₂ administration in dental settings are nausea and vomiting.^{15,28–31} This survey showed that most senior students (seventh-year), who were expected to be more confident in managing such side effects, demonstrated a lack of confidence in comparison to sixth- and fifth-year students. This might be attributed to the real-life scenarios in managing real patients throughout their studies. Whereas the higher confidence levels of fifth- and sixth-year dental students might have stemmed from their theoretical knowledge as well as the lack of clinical experience in managing postoperative nausea and vomiting after N₂O/O₂ sedation.

This study has several limitations that may affect the overall inferences. These include the small number of participants, relying on students' subjective confident-level recall and its recent module addition into the curriculum. At Kuwait University Faculty of Dentistry, the N₂O/O₂ inhalation sedation module does need further evaluation and improvement to refine its content and teaching methodology. Additional modules involving focused training could be added to the sixth-year curriculum, and the number of required cases could be adjusted

to reflect the changes needed to improve the overall educational outcome. Therefore, future module evaluation should aim to investigate other perspectives of N₂O/O₂ inhalation sedation practice through objective assessments and re-assess dental students' confidence level regularly. Another point worth considering is to submit the same survey to young dentists, with few years of experience, to evaluate their knowledge and confidence level towards the use of N₂O/O₂ inhalation sedation. A previous survey showed that the enthusiasm for using such services wanes with time.⁴

Conclusion

The teaching curriculum of N₂O/O₂ inhalation sedation in dental schools should be regularly evaluated in order to assess its strengths and weaknesses. Physical experience of providing N₂O/O₂ inhalation sedation gives dental students the greatest confidence level. This can be achieved through the opportunities afforded by the undergraduate curriculum, which allows students to learn and develop through consolidation of theory and response to challenges. Assessing the quality of students' educational pathways through surveys should be considered as an essential part in dental school curricula improvement and development.

Disclosure

The authors declare no conflicts of interest in this work.

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