Nitrous oxide/oxygen conscious sedation: clinical safety and usefulness

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INTRODUCTION

Whitwam and McCloy[1] define conscious sedation as 'a controlled state of pharmacological depression of consciousness that maintains protective reflexes, retains a patent airway independently and continuously, and permits appropriate responses to physical stimulation or verbal command.' It is a state similar to that of 'Minimal Sedation' (Anxiolysis), defined by the American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists as a 'state that although cognitive function and co-ordination may be slightly impaired, 'ventilatory and cardiovascular functions are unaffected.'[2]

Clearly, this is much lighter than deep sedation, where consciousness is lost and there is a loss, or partial loss, of protective reflexes and an inability to respond to verbal commands. Conscious sedation is thus even further removed from general anaesthesia where there is a complete loss of protective reflexes and unconsciousness occurs.[1,3-6]

In comparison with other drugs, nitrous oxide/oxygen is the safest, most effective agent for out-patient dentistry, readily producing conscious or minimal sedation.[3] Provided that the operator has the required theoretical and practical training and that the correct technique and equipment is used, a mixture of nitrous oxide and oxygen is almost ideal to produce this state.[3,7] It has been claimed that the technique 'has never been replaced and has stood the test of time'.[7] N_2O is a natural constituent of the atmosphere (0.5 ppm)[8] and should not be confused with nitric oxide (NO), a closely related chemical.

HISTORY

The early use of N_2O by Davy, and the discovery of anaesthesia by Horace Wells more than forty years later, are well known.[7,9,10] Nonetheless, there are many who dispute Wells' rightful claim as the discoverer of general anaesthesia.[8] Less well known is the fact that Davy conducted his pioneering human experiments at concentrations similar to those currently used by dentists or that the first general anesthetic operation was the extraction of Well's own third molar.[8] Also relatively unknown is that it was a Polish physician, working in Russia, S.S. Klikovich, who was the first practitioner to realise the potential of using N_2O for its anxiolytic and analgesic effects.[11] He used it successfully at concentrations currently recommended by modern dentists for conscious sedation, but for obstetrics, asthma and angina.[11] Since the work of Klikovitch, the medical profession has largely confined the use of nitrous oxide for conscious sedation to obstetrics and general anaesthesia.[3] Over the ensuing more than 150 years, N_2O has proved a safe and effective agent, and there are few if any other agents currently used for medicine and dentistry that has such an outstanding record of safety and efficacy.[1,4,6,7,12] Indeed, Jastak has noted that when used correctly it is, '… one of the safest drugs in clinical practice.'[13]

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It is however, important to distinguish between anaesthesia and analgesia. N_2O has low potency as an anaesthetic agent, requiring hyperbaric conditions to produce safe surgical anaesthesia. While the administration of N_2O as an anaesthetic by single-handed dental practitioners is hazardous, this does not apply to the low concentrations used to achieve analgesia in conscious sedation, or inhalation sedation.[3,7]

The descriptive term "psychotropic analgesic nitrous oxide (PAN)" has been recommended when non-anaesthetic concentrations of N_2O are used, as in dentistry, to evoke the anxiolytic, anti-stress and mood-elevating effects of the gas.[5] In dentistry, the availability of reliable and safe local anaesthetic agents in the 1940's led to the widespread use of PAN for conscious sedation. It has been popular among dentists ever since.[3]

PHARMACOLOGY

N_2O at levels used for conscious sedation (PAN) fulfills the criteria to be described as a partial opioid agonist.[5,10,17] In common with other opioids e.g. morphine and pethidine) it nevertheless acts on neurotransmitter systems such as the adrenergic, dopaminergic and GABA-ergic.[5,17] Idiosyncratic sensitivity to N_2O is rare but has been encountered.[4]

PRACTICAL NOTES

The dedicated equipment for the administration of N_2O/O_2 in providing conscious sedation has important safety features. Training in the use of this equipment is essential, involving a short course of a few hours duration.[4] A built-in fail-safe device halts the supply of N_2O should the oxygen flow to the patient fall below 30%.[3,4] As a result, the danger of hypoxia is avoided.[1,3-5,21] particularly as a nasal mask and not a facial mask is used.[3] The dose is titrated for every patient and in any event, the effects of PAN can be reversed within seconds by substituting pure oxygen. Although intravenous benzodiazepines can also be titrated very accurately, reversal of the effects of those drugs is unlikely to be as rapid, safe or predictable.[3]

PAN can be used alone or in combination with almost all available sedative agents (oral or parenteral), including opioids, benzodiazepines, chloral hydrate and local

anaesthetics.[4] However, such combinations can result in deep sedation or anaesthesia, an effect which should be avoided for those operators more extensively qualified.[2,3]

N_2O is also non-allergenic and can be used safely in patients with poor renal and/or hepatic function.[3,4] It also acts synergistically with hypnotherapy, audioanalgesia, acupuncture and electroanalgesia.[19]

PAN can be useful for all dental procedures, from conservation to paediatric dentistry and in surgical procedures including implants and third molar extractions.[4] In medicine it has been used in numerous clinical situations including paediatric surgery, radiology, opthalmology, terminal refractory pain, emergency medicine and painful medical procedures as well as the treatment of substance abuse withdrawal states.[6] It can also be used by properly trained dentists to treat nicotine abuse, in which case it is appropriate that the medical practitioners' tariff code (0203/0204) plus the dental code (8141/8143) plus the modifier 007, are applied.[20]

PATIENT SAFETY AND MONITORING WHEN USING N_2O/O_2 CONSCIOUS SEDATION

Safety of N_2O/O_2

The safety of N_2O/O_2 for conscious sedation (i.e. PAN) has been well established and indeed, in combination with local anaesthesia (LA), is safer than LA on its own.[3,13] The unpleasant side effects of LA are reduced or avoided, including syncope, which on rare occasions is accompanied by drastic blood pressure changes, attacks of angina and vomiting with aspiration.[3] Of course, N_2O/O_2 does produce minor side-effects, which are relatively rare e.g. nausea or headache, which usually can be avoided by adequate post-operative oxygenation.[3]

Contraindications

PAN should be avoided in chronic obstructive pulmonary disease or pneumothorax, or where the patient is receiving bleomycin sulphate for various neoplasms, including lymphomas, squamous carcinomas and testicular tumours.[3,4] Concentrations in excess of 30% of oxygen can cause pulmonary fibrosis in patients receiving bleomycin sulphate. As N_2O oxidizes vitamin B_{12}, patients with severe B_{12} avitaminosis should be preloaded with either the vitamin or with folinic acid, which are protective.[4] Careful history taking is certainly essential when using N_2O.

Safe patient monitoring

When using N_2O/O_2 conscious sedation, no specialised monitoring equipment is required, as long as no other sedative drugs are used.[4]

CONSIDERATIONS FOR STAFF SAFETY

Importance of scavenging with N_2O

Low level chronic exposure can result in dyshaemopoiesis which can be severe enough to produce agranulocytosis.[4,22] Female infertility and spontaneous abortions can also follow chronic pollutant exposure. These consequences may be a problem for the dentist and dental staff. However, there are no clinical sequelae for healthy patients exposed for up to 5 hours of continuous N_2O at anaesthetic concentrations, which are much higher than those used for N_2O/O_2 conscious sedation.[3,4] Simple inexpensive scavenging will avoid all of these untoward effects.

Apart from the fact that it is unethical to knowingly expose staff to a potential biohazard, it is a criminal offence.[22]

N_2O abuse

N_2O abuse is so rare that it has been described as a "toxilogical curiosity" and is usually confined to those health professionals who have easy access to the gas, such as dentists, anesthetists and nurses. However, it may cause a serious syndrome which is similar to combined degeneration of the spinal cord, due to demyelination.[3,6]

CONCLUSION

Conscious sedation is a state which never approaches anything near anaesthesia, and there is no other technique as safe, as rapidly effective, as swiftly and simply reversible as the N_2O/O_2 admixture, despite all the advances of modern medicine.[3,4,12,13] It could therefore substitute for most general anaesthetics used in routine dentistry.

Conflict of interest: Since 2003 I have been the medical adviser to Sedatek, a company that sells conscious sedation equipment. I have no shareholding in Sedatek.

References

1. Whitwam JG, McCloy RF. Principles and Practice of Sedation. 2nd Edition: Oxford: London: Blackwell Science, 1998.
2. American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. Practice guidelines for Non-Anesthesiologists. Anesthesiology 2002; 96: 1004-17.
3. Gillman MA. Most effective method in routine conscious sedation for ambulatory patients. SADJ. 2004; 59: 363-6.
4. Clark M, Brunick A. Handbook of Nitrous Oxide and Oxygen Sedation. St Louis: Mosby, 2008.
5. Gillman MA, Lichtigfeld FJ. Opioid properties of psychotropic analgesic nitrous oxide (Laughing Gas). Perspect Biol Med. 1994; 38: 125-38.
6. Gillman MA, Lichtigfeld FJ, Young T. Psychotropic analgesic nitrous oxide for alcoholic withdrawal states. (Review). The Cochrane Library. 2008; Issue 2.
7. Wynne JM. Physics, chemistry, and manufacture of nitrous oxide. In Nitrous oxide/N_2O, edit. El.Eger II, pp.23-39. New York: Elsevier, 1985.
8. Frost, E.A.M. A History of Nitrous Oxide. In Nitrous oxide/N_2O, edit. El.Eger II, pp.1-22. New York: Elsevier, 1985.
9. Davy, H. Researches Chemical and Philosophical Chiefly Concerning Nitrous Oxide. (facsimile of 1800 edition). London: Butterworth,1977.
10. Gillman MA. Nitrous Oxide and Neurotransmission. New York: Novo Science, 2012.
11. Richards W, Parbrook GD, Wilson J. Stanislav Klikovich (1853-1910). Anaesthesia. 1976; 31: 933-40.
12. D'Eramo E.M. Mortality and morbidity with outpatient anesthesia: The Massachusetts experience. J Oral Max Surg. 1999; 57: 531-6.
13. Jastak JT. Nitrous oxide in dental practice. Int Anesth Clin. 1989; 27: 92-7.
14. Parkhouse J, Henrie JR, Duncan GM, Rome HP. Nitrous oxide analgesia in relation to mental performance. J Pharm Exp Ther. 1960; 128: 44-8.
15. Dwyer R, Bennett HL, Eger II EI, Helilbron D. Effects of isoflurane and nitrous oxide in sub-anesthetic concentrations on memory and responsiveness in volunteers. Anaesthesiology. 1992; 888-98.
16. Cheam EWS, Dob DP, Skelly AM, Lochwood GG. The effect of nitrous oxide on the performance of psychomotor tests. Anaesthesia. 1995; 50: 764-8.
17. Gillman MA. Analgesic nitrous oxide should join the opioid family after almost two centuries. S Afr J Sci. 1993; 89:25-7.
18. Marshall BE, Longnecker DE. General Anesthetics. In : eds. JG Hardman, LE, Limbird, PB Molinoff, RW Ruddon, AG Gilman. Goodman and Gilman's The Pharmacological Basis of Therapeutics. New York: Mcgraw-Hill, pp. 307-30, 1996.
19. Stanley TH, Cazalaa JA Limoge A,Louville Y. Transcutaneous cranial electrical stimulation increases the potency of nitrous oxide in humans. Anesthesiology. 1982; 57: 293-7.
20. Gillman MA. Using Nitrous Oxide/Oxygen (PAN) Sedation for Treating Nicotine Dependence: A Manual for Health Professionals. Johannesburg: Cerebrum Publishers, 2010.
21. Anonymous. SADA Guidelines for Conscious Sedation in Dentistry (Insert) SADJ, April 2007.
22. Gillman MA. Editorial. It is illegal and unethical to use nitrous oxide/oxygen conscious sedation without scavenging. SADJ. 2006; 61: 302.