Nitrous oxide/oxygen conscious sedation: clinical safety and usefulness

SADJ August 2015, Vol 70 no 7 p306 - p307

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INTRODUCTION
Whitwam and McClay 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.’

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.

In comparison with other drugs, nitrous oxide/oxygen is the safest, most effective agent for out-patient dentistry, readily producing conscious or minimal sedation. 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. It has been claimed that the technique ‘has never been replaced and has stood the test of time’. N2O is a natural constituent of the atmosphere (0.5 ppm) and should not be confused with nitric oxide (NO), a closely related chemical.

HISTORY
The early use of N2O by Davy, and the discovery of anaesthesia by Horace Wells more than forty years later, are well known. Nonetheless, there are many who dispute Wells’ rightful claim as the discoverer of general anaesthesia. 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. 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 N2O for its anxiolytic and analgesic effects. He used it successfully at concentrations currently recommended by modern dentists for conscious sedation, but for obstetrics, asthma and angina. Since the work of Klikovich, the medical profession has largely confined the use of nitrous oxide for conscious sedation to obstetrics and general anaesthesia. Over the ensuing more than 150 years, N2O 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. Indeed, Jastak has noted that when used correctly it is, ‘one of the safest drugs in clinical practice.’

It is however, important to distinguish between anaesthesia and analgesia. N2O has low potency as an anaesthetic agent, requiring hyperbaric conditions to produce safe surgical anaesthesia. While the administration of N2O 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.

The descriptive term ‘psychotrope analgesic nitrous oxide (PAN)’ has been recommended when non-anaesthetic concentrations of N2O are used, as in dentistry, to evoke the anxiolytic, anti-stress and mood-elevating effects of the gas. 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.

PHARMACOLOGY
N2O at levels used for conscious sedation (PAN) fulfills the criteria to be described as a partial opioid agonist. In common with other opioids e.g. morphine and pethidine it nevertheless acts on neurotransmitter systems such as the adrenergic, dopaminergic and GABA-ergic. Idiosyncratic sensitivity to N2O is rare but has been encountered.

PRACTICAL NOTES
The dedicated equipment for the administration of N2O/O2 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. A built-in fail-safe device halts the supply of N2O should the oxygen flow to the patient fall below 30%. As a result, the danger of hypoxia is avoided. Particular care must be taken with a patient who has a nasal mask as and not a facial mask is used. 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.

PAN can be used alone or in combination with almost all available sedative agents (oral or parenteral), including opioids, benzodiazepines, chloral hydrate and local sedation.
anaesthetics. However, such combinations can result in deep sedation or anaesthesia, an effect which should be avoided for those operators more extensively qualified.\textsuperscript{2,3} N\textsubscript{2}O is also non-allergic and can be used safely in patients with poor renal and/or hepatic function.\textsuperscript{2,4} It also acts synergistically with hypnotherapy, audioanalgnesia, acupuncture and electroanalgnesia.\textsuperscript{19}

PAN can be useful for all dental procedures, from conservation to paediatric dentistry and in surgical procedures including implants and third molar extractions.\textsuperscript{1} In medicine it has been used in numerous clinical situations including paediatric surgery, radiology, ophthalmology, terminal refractory pain, emergency medicine and painful medical procedures as well as the treatment of substance abuse withdrawal states.\textsuperscript{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.\textsuperscript{20}

\textbf{PATIENT SAFETY AND MONITORING WHEN USING N\textsubscript{2}O/O\textsubscript{2} CONSCIOUS SEDATION}

\textbf{Safety of N\textsubscript{2}O/O\textsubscript{2}}

The safety of N\textsubscript{2}O/O\textsubscript{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.\textsuperscript{3,17} 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.\textsuperscript{3} Of course, N\textsubscript{2}O/O\textsubscript{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.\textsuperscript{3}

\textbf{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.\textsuperscript{3,4} Concentrations in excess of 30% of oxygen can cause pulmonary fibrosis in patients receiving bleomycin sulphate. As N\textsubscript{2}O oxidizes vitamin B\textsubscript{12}, patients with severe B\textsubscript{12} avitaminosis should be preloaded with either the vitamin or with folinic acid, which are protective.\textsuperscript{3} Careful history taking is certainly essential when using N\textsubscript{2}O.

\textbf{Safe patient monitoring}

When using N\textsubscript{2}O/O\textsubscript{2} conscious sedation, no specialised monitoring equipment is required, as long as no other sedative drugs are used.\textsuperscript{4}

\textbf{CONSIDERATIONS FOR STAFF SAFETY}

\textbf{Importance of scavenging with N\textsubscript{2}O}

Low level chronic exposure can result in dyshaemopoiesis which can be severe enough to produce agranulocytosis.\textsuperscript{1,22} 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\textsubscript{2}O at anaesthetic concentrations, which are much higher than those used for N\textsubscript{2}O/O\textsubscript{2} conscious sedation.\textsuperscript{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.\textsuperscript{22}

\textbf{N\textsubscript{2}O abuse}

N\textsubscript{2}O abuse is so rare that it has been described as a “toxicological 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.\textsuperscript{3,6}

\textbf{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\textsubscript{2}O/O\textsubscript{2} admixture, despite all the advances of modern medicine.\textsuperscript{3,4,12,13} It could therefore substitute for most general anaesthetics used in routine dentistry.

\textbf{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.

\textbf{References}