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Review article

Conscious sedation in pediatric dentistry. A short review of the current UK guidelines and the technique of inhalational sedation with nitrous oxide

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Conscious sedation is used in pediatric dentistry as elsewhere to reduce fear and anxiety in pediatric patients and so promote favorable treatment outcomes. This can help to develop a long-term positive psychological response to necessary dental procedures.

The publication of 'A Conscious Decision' in 2000 (1) resulted in the cessation of general anesthesia for dentistry in the primary care setting. Up to this date, there had been an increased emphasis on the safe provision of conscious sedation for management of pain and anxiety in child and adult patients and this has continued following the removal of general anesthesia in the primary care.

Several recent guidelines have sought to provide advice to general dental practitioners, community dentists and those in the hospital setting on the use of conscious sedation for both children and adults.

The British Society of Paediatric Dentistry (BSPD) produced the UK Clinical Guidelines in pediatric dentistry for conscious sedation in children in 2002 (2) and in combination with the Scottish Intercollegiate Guidelines Network (SIGN), which published the Safe Sedation for Children guideline in the same year (3). Practitioners were able to understand the evidence base behind various techniques.

The UK Department of Health sponsored an independent working party the Standing Dental Advisory Committee (SDAC) to develop further guidelines, which were published in 2003 (4). These guidelines were endorsed by the General Dental Council (GDC) and dental professionals are expected to follow it. Therefore, the SDAC report is now considered as professional regulation in combination with the GDC's own Standards guidance of 2005 (5). This year has also seen the publication of the Scottish Dental Clinical Effectiveness Programme's [SDCEP is an initiative of the National Dental Advisory Committee (NDAC)]. Conscious sedation in dentistry seeks to update and extend the SDAC guidance (6).

Currently, different forms of sedation, for example, oral, intravenous (i.v.), inhalation, intranasal and combinations of treatments are used for pediatric dental patients worldwide. Some of these techniques do not comply with the UK definition of conscious or moderate sedation (3), where the patient remains in verbal contact throughout treatment and the margin of safety is wide enough to render the loss of consciousness unlikely [NDAC, GDC, SDAC, Dental Sedation Teachers Group (DSTG)]. In the UK, the state of deep sedation is considered to be a part of the spectrum of general anesthesia and this has sometimes caused confusion in comparing different research studies from other countries. A recent Cochrane systematic review (7) found evidence for a variety of techniques that have been used to provide safe and effective conscious sedation for children requiring dental procedures. However, there were few studies that fitted the selection criteria for the review (randomized controlled clinical trials) and it was not possible with the

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available evidence to reach a definitive conclusion on the most effective method for conscious sedation of pediatric dental patients. The authors recommend the development of guidelines and further continuing research. A similar review looking at available worldwide studies from 1966 to the present came to a similar conclusion (8).

In the UK, there is considerable interest in dedicated pediatric hospital units in providing a sound evidence base for the use of various sedation techniques; recent studies have shown the success of i.v. and oral midazolam, i.v. propofol and inhalation sedation using sevoflurane (9–12). Several of the studies quoted have compared i.v. or oral techniques directly with the established technique of nitrous oxide/oxygen inhalation sedation. Currently, inhalation sedation using nitrous oxide is suggested as the treatment of choice for dentistry in pediatric patients in the primary care setting by the BSPD, SDAC, NDAC, and GDC. The latest guideline [NDAC 2006 (6)] suggests i.v., oral, and transmucosal forms of sedation should only be provided by those specifically trained in these techniques for patients in this age group; and that these techniques are only appropriate in a minority of cases. These conclusions have been drawn as a consensus of expert opinion and reflect the current lack of high quality evidence for the most suitable technique for pediatric dental sedation.

Figure 1
Inhalation sedation with nitrous oxide has been shown to be effective for dental extractions in anxious pediatric patients (13).

Inhalation sedation with nitrous oxide

Inhalation sedation with nitrous oxide has been established as a method for conscious sedation for many years. The technique uses subanesthetic concentrations of nitrous oxide delivered with oxygen in a titratable dose from dedicated machinery via a nasal mask (Figure 1).

Nitrous oxide is poorly soluble with a high minimum alveolar concentration (MAC value), rapid onset of action is therefore coupled with a rapid recovery period; the duration of the sedation is controlled and the patient can quickly return to normal activities. Patients do not need to be fasted and adults (over 16 years) do not need to be accompanied for treatment after their first visit (6). It is not used in isolation from the support given by the dentist but has been shown to be very successful in facilitating treatment for children with mild to moderate anxiety (2). It is a viable and cost-effective alternative to general anesthesia for children requiring extractions, especially orthodontic extractions, with the exception of very young children requiring multiple extractions and irregular attenders (13,14).

There are few disadvantages to the technique although precooperative children and those who cannot accept a nasal mask or breathe adequately through the nose may be unable to tolerate this form of sedation. There have been no recorded fatalities or cases of serious morbidity associated with the technique when it has been used alone and in concentrations appropriate for conscious sedation (15,16). Nitrous oxide has no excretion products being eliminated unchanged through the lungs and is therefore useful in patients who have kidney or liver disorders. Patients with cardiovascular or

cerebrovascular disease especially those at risk of ischemic episodes can benefit from the technique from both the anxiolysis effects and the enriched oxygen given as part of the technique. Nitrous oxide sedation is suitable for patients with sickle cell trait or the full disease, asthmatics, epileptics, where the onset of seizures is reduced, and diabetics (17). This technique has been shown to be effective as an alternative to general anesthesia for dental extractions, which is significant for these medically compromised patients.

Caution should, however, be used in those patients with chronic obstructive pulmonary disease (because of the enriched oxygen), pregnancy, severe asthma, and psychiatric disorders. Nitrous oxide has a solubility 15 times that of nitrogen. High doses can therefore cause gaseous expansion and rupture of enclosed air spaces and it should not be used when treating patients with middle ear disease, including infections or those with intestinal obstruction (15,17).

Figure 2
A pediatric patient undergoing treatment of the upper permanent incisors. The rubber dam isolation helps prevent operator pollution through mouth breathing as well as isolating the operating field.

Pollution

Practitioners should be aware of the deleterious effects from chronic occupational exposure and comply with health and safety requirements in respect of nitrous oxide pollution and gas safety (18). Nitrous oxide inhibits vitamin B12 metabolism and can cause liver, kidney, and neurological disease. It is also a greenhouse gas and these problems have led to research using other agents such as sevoflurane.

To limit the pollution effects The Health and Safety Executive in the UK and similar bodies around the world have established exposure guidelines and recommendations for adequate ventilation of dental surgeries and the use of a form of active scavenging to remove expired nitrous oxide. There are also guidelines on the storage of gas cylinders and the design of the equipment used to deliver the nitrous oxide. Training in the technique should reinforce the need to remind patients to breathe through the nose and not mouth breathe (a common feature of very young patients) both to allow nitrous oxide to be actually inhaled and to reduce pollution to the operator and assistant. The use of rubber dam for routine restorative procedures can significantly reduce pollution through mouth breathing (Figure 2). In following these recommendations, it is possible to keep exposure within the recommended limits (18,19).

Training

The technique for administration of nitrous oxide sedation is straightforward but requires formal training at the undergraduate or postgraduate level; training standards have recently been outlined by the DSTG (20). Training should include supervised clinical practice for the whole dental team.

The importance of suitable behavior management techniques and the use of semihypnotic suggestion should not be underestimated and requires practice by the operator. The machines currently available commercially must comply with the guidelines described and all feature a 70% nitrous oxide limiter, automatic nitrous oxide cut out in the event of oxygen failure, emergency oxygen override, proportional nitrous oxide/oxygen delivery and color-coded cylinders with a pin index loading system.

Technique

Following a full assessment of the patient's dental and medical history and written consent for the procedure, the patient is settled in the chair. An incremental introduction of nitrous oxide delivered through a simple nasal mask allows the patient's response to be carefully monitored, particularly if the operator is also inexperienced in the use of the

technique. Generally between 20% and 40% nitrous oxide (with 80–60% oxygen) results in an adequate level of sedation for dental treatment. The patient is awake, relaxed, comfortable, and able to maintain an open mouth for treatment, but there is a reduction in spontaneous movements. Pulse, blood pressure, and the respiratory rate are normal with the pupils normal and responsive to light. The laryngeal reflex remains intact (21). The patient may feel a range of subjective symptoms: mild intoxication and euphoria, paresthesia of the extremities, a sense of detachment and a lessened response to pain. Increasing the flow of nitrous oxide from 50% to 70% results in an increased sense of detachment, dizziness, nausea and disorientation for the patient, coupled with a reduction in the pharyngeal and laryngeal reflexes. The patient may not be able to maintain an open mouth and verbal contact may be lost. It is therefore important that the operator appreciates that increasing the level of nitrous oxide given will result in less successful treatment, and mouth props should never be used as the ability to open the mouth for treatment is an important clinical indicator of the level of sedation.

For all but the simplest of treatments local anesthesia in the dose appropriate for the age of the patient and procedure planned, is still required as the analgesic effects of nitrous oxide are too weak for most dental procedures. If the patient appears too heavily sedated (very drowsy or unable to maintain an open mouth) the nitrous oxide level should be reduced.

The patient is recovered with 100% oxygen to prevent a possible diffusion hypoxia as nitrous oxide is expired through the lungs, and postoperatively given advice to avoid demanding physical activity. Unlike i.v. or oral agents, adult patients are not restricted to drive or operate machinery postoperatively (6).

Suitable techniques for conscious sedation of pediatric dental patients continue to be the object of discussion and research and continued expansion of a sound evidence base is welcomed by this author.

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