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UK National Clinical Guidelines in Paediatric Dentistry*

Introduction

The twelfth National Clinical Guideline in Paediatric Dentistry is published here. The process of guideline production began in 1994, resulting in first publication in 1997. Each guideline has a nominated main author but the content is not a personal view; it represents rather a consensus of opinion of current best clinical practice. Each guideline has been circulated to all consultants in paediatric dentistry in the UK, to the Council of the BSPD, and to people of related specialities recognized to have expertise in the subject. The final version of the guideline is produced from a combination of this input and thorough review of published literature. The intention is to encourage improvement in clinical practice and to stimulate research and clinical audit in areas where scientific evidence is inadequate. Evidence underlying recommendations is scored according to the SIGN classification and guidelines should be read in this context. For those wishing further detail, the process of guideline production in the UK is described in *International Journal of Paediatric Dentistry* 1997; **7**: 267–268.

Managing anxious children: the use of conscious sedation in paediatric dentistry

M. T. HOSEY

Introduction

All children should be able to expect painless, high quality dental care. The following guideline is intended to assist dentists in the management of healthy anxious children; discussion of the sedation of medically compromised children or those with a learning disability is not included.

Behavioural management and prevention, coupled with local anaesthesia when required, form the foundation of the delivery of pain-free dentistry to children. Although behavioural management may need to be augmented with conscious sedation for some anxious children, pharmacological agents are not substitutes for effective communication and the persuasive ability of the operator. There is certainly no place for invasive and high-risk sedative techniques such as deep sedation or polypharmacy in the dental management of anxious children within paediatric dental care in the UK. Indeed, even in parts of the world where deep sedation techniques are more common, their use is often limited to hospitals [1]. Nitrous oxide inhalation sedation remains the preferred technique for the pharmacological management of anxious paediatric dental patients.

It is hoped that this guideline will be an adjunct to clinical judgement and careful treatment planning within both primary dental care and specialist paediatric dentistry practice. It is therefore generally assumed that the dentist is also the sedationist. Restraining devices (such as the papoose board) and deep sedation techniques (where the patient is more deeply sedated than the General Dental Council definition of conscious sedation [2]) are not acceptable in UK dental practice. Where there is evidence or a substantive body of opinion relating to a specific drug or route indicating that deep sedation might occur, or where research is meagre, referral to a hospital-based paediatric dental service and, where

Correspondence: Marie Therese Hosey, University of Glasgow, Glasgow, UK. E-mail: m.t.hosey@dental.gla.ac.uk

Table 1. ASA Classification.

Class I	No organic, physiological, biochemical or psychiatric disturbance.
Class II	Mild to moderate systemic disturbance, e.g. mild diabetes, moderate anaemia, well-controlled asthma, not disabling.
Class III	Severe systemic disease, e.g. severe diabetes with vascular complications, severe pulmonary insufficiency, disabling.
Class IV	Severe systemic disorders that are already life-threatening, e.g. signs of cardiac insufficiency.
Class V	The moribund patient who has little chance of survival without operative intervention.

appropriate, the assistance of a qualified anaesthetist has been recommended. As such, not all drugs reported in this guideline are recommended for use in primary care dentistry in the UK, but are included because the author is aware that the diversity of published literature might lead some dental practitioners to consider using them in an effort to find an alternative to general anaesthesia.

These guidelines should be read in the context of the contemporary recommendations of the GDC and the UK national and regional government and other respected authorities, particularly in respect of appropriate qualifications, staffing level, training, equipment and facilities.

This guideline is based on the evidence currently available but even although the paediatric dental sedation literature is extensive, there are relatively few randomised controlled trials. Furthermore, the evaluation of the efficacy of an individual drug is often confounded by the use of polypharmacy, restraining devices and diverse methodology. The Poswillo Report [3] clearly stated that conscious sedation should involve the administration of a single drug. In the light of the paucity of evidence to the converse, and in the interest of the safety and well-being of child dental patients, this guideline will apply this principle to children's dentistry in the UK.

1.0 Conscious sedation

1.1 General Dental Council definition

A technique in which the use of a drug or drugs produces a state of depression of the central nervous system enabling treatment to be carried out, but during which verbal contact with the patient is maintained throughout the period of sedation. The drugs and techniques used to provide conscious sedation for dental treatment should carry a margin of safety wide enough to render unintended loss of consciousness unlikely.

The level of sedation must be such that the patient remains conscious, retains protective reflexes, and is able to understand and to respond to verbal commands [2].

1.2 Goals of paediatric conscious sedation are to:

Grade C

1 Promote patient welfare and safety.
2 Facilitate the provision of quality care.
3 Minimize the extremes of disruptive behaviour.
4 Promote a positive psychological response to treatment.
5 Return the child to a physiological state in which safe discharge is possible [4].

1.3 Patient assessment

Grade C

- This must include a full medical and dental history and must be performed before the decision to provide treatment under conscious sedation is made.

1.4 Fitness for conscious sedation

Grade C

- Children who are ASA I or II (Table 1) can be deemed fit to undergo conscious sedation in general, community or specialist (paediatric) practice.
- Those who are not in these categories requiring conscious sedation should be treated in a hospital environment with due consideration to their individual needs and medical condition, involving the assistance of medical colleagues where appropriate.

1.5 Patient information and consent [2]

Grade C

- Informed consent for a course of dental treatment under conscious sedation must be obtained from each parent/guardian, and the child, where appropriate, prior to the conscious sedation appointment.
- An explanation of the sedation technique proposed and of appropriate alternative methods of pain and anxiety control must be given.
- In advance of the procedure, the child and their parent or guardian must be given clear and comprehensive pre- and postoperative instructions in writing.

1.6 Escort

Grade C
- A parent, legal guardian or other responsible adult must accompany the child to and from the treatment facility.
- A sedated child must always be attended by a suitably qualified member of the dental team.
- The sedationist should be chaperoned at all times by another member of staff.

1.7 Fasting

Grade C
- Fasting is not required for children undergoing inhalation sedation using nitrous oxide but dentists might recommend that a light meal only is consumed in the two hours prior to the appointment.

Grade C
- Children who undergo all other forms of sedation should be fasted prior to the procedure as follows:
- No solid food within 6 h
- No milk within 4 h
- No clear fluid within 2 h

1.8 Documentation

Grade C
The notes must:

- Include the name and signature of the operator together with the name(s) of the assistants.
- Contain a clear treatment plan, completed medical history and consent form, appropriate radiographs and briefly give an account of the reason for the need for sedation.
- Document the operative treatment that was performed, the name of the drug, concentration and batch number (if appropriate), dosage, route and duration of sedation.
- State which monitors were used (as appropriate) together with their readings.
- Include a time-based record where appropriate.

1.9 Staff training requirements

Grade C
- The dental team must undergo appropriate training on a regular basis as determined by competent authorities.
- It is essential that primary care dentists who sedate children undergo training that is recognized by appropriate authorities and that their clinical skill and knowledge relating to paediatric conscious sedation, including local anaesthesia, behavioural management and the provision of operative dental care for children, is regularly updated.
- The dental nurse should be appropriately trained in sedation techniques. Attainment of the Certificate in Dental Sedation Nursing (CDSN) from the National Examining Board for Dental Nurses (NEBDN) is encouraged.
- Specialist paediatric dentists are expected to have acquired the necessary skills and competency for nitrous oxide inhalation conscious sedation, but such individuals are still obliged to update themselves regularly and to adhere to national and regional policy and procedure.

2.0 Choice of sedative agent for children undergoing dental treatment

The drug groups used for paediatric dental sedation include inhalational agents, benzodiazepines, other sedative hypnotics and psychosedatives.

2.1 Nitrous oxide

2.1.1 Indications

Grade A
Nitrous oxide inhalation sedation:

- Should be offered to children with mild to moderate anxiety to enable them to accept dental treatment better and to facilitate coping across sequential visits.
- Should not be used in isolation from the support given to the child by the dentist.

Grade B
- Can be used to facilitate dental extractions in children.
- Is preferred to general anaesthesia for anxious children undergoing elective orthodontic (premolar) extractions.
- Is a cost effective alternative to general anaesthesia.
- Is a weak analgesic, although this effect can be influenced by the psychological preparation of the patient.

Grade C
- Has a minimal effect on cardiovascular and respiratory function.

2.1.2 Contra-indications

Nitrous oxide inhalation sedation:

Grade B
- Is of less value in those who require multiple extractions, poor attenders and very young children.

Grade C
Contra-indications to nitrous oxide inhalation sedation include:

- Common cold, tonsillitis, nasal blockage and bleomycin chemotherapy [5].
- Pre-co-operative children.
- First trimester of pregnancy.

2.1.3 Nitrous oxide pollution

Grade C
- Dental operators should ensure that they comply with COSHH [6] in respect of N_2O pollution and gas safety.

2.1.4 Other inhalational agents

Grade C
- Although isoflurane and other inhalational agents such as sevoflurane have been reported, their use in children should be limited until further research emerges.

2.2 Diazepam and temazepam

2.2.1

Grade B
- Oral benzodiazepines can be used to relax anxious patients prior to dental treatment but their effects can be unpredictable in children.

2.2.2 Rectal diazepam

Grade B
- The anterograde amnesia produced might be of value to those children who have to undergo traumatic dental procedures.

2.2.3 Intravenous diazepam

Grade C
- There is no role for intravenous diazepam sedation in paediatric dentistry.

2.3 Midazolam

2.3.1 **Grade B**
- Midazolam is generally reserved for anxious adolescent or adult dental patients.
- It can cause disinhibition rather than sedation in children.

2.3.2 **Grade C**

Oral midazolam:
- May have a potential value as a pre-medication and sedative agent.
- Is not recommended for use outwith a hospital environment.

2.3.3

Intra-nasal midazolam:

Grade B
- Is not recommended in children who have copious nasal secretions or who suffer from an upper respiratory tract infection.
- Is not recommended for use outwith a hospital environment.

2.3.4

Rectal midazolam:

Grade A
- Can facilitate restorative treatment in uncooperative children.

Grade C
- Should only be attempted in a hospital facility with the assistance of a qualified anaesthetist.

2.3.5 **Grade C**
Intramuscular midazolam:
- Is not recommended for conscious sedation in paediatric dentistry.

2.4 Flumazenil (Anexate)

Grade B
- Reversal with Flumazenil should not be used as a routine part of the conscious sedation procedure.
- Flumazenil may induce convulsions [7].

2.5 Opioids and other miscellaneous agents with sedative properties (chloral hydrate, hydroxyzine, promethyaine hydrochloride, fentanyl & pethidine)

2.5.1 **Grade C**
- The efficacy of these drugs is questionable and the associated risks may outweigh their benefit.

- Repeated administration of chloral hydrate carries a theoretical risk of carcinogenesis.
- These drugs are not recommended outwith a hospital environment.

2.5.2 **Grade C**
- The use of narcotics such as pethidine is not recommended in the UK.
- Fentanyl and other potent opioids should only be used by a qualified anaesthetist in a hospital setting.

2.6 Common anaesthetic agents that are used as sedatives

2.6.1 Propofol

Grade C
- The use of propofol in paediatric dentistry is still experimental and requires the assistance of a qualified anaesthetist in a hospital environment.

2.6.2 Ketamine

Grade C
- Ketamine should only be administered by a qualified anaesthetist in a hospital environment.

3.0 Routes of administration

3.1 Inhalation

Grade C
- **This is the recommended route for conscious sedation for paediatric dentistry**

Grade B
- The inhalational route is the most reliable in terms of onset and recovery.
- Efficacy is reduced when children object to the nasal hood or have difficulty breathing through the nose.

Grade C
- Only dedicated dental nitrous oxide inhalation sedation delivery systems must be used.
- The operator should use a close-fitting scavenging nasal hood. An air-entrainment valve is not required.
- The use of a rubber dam improves the effect of the sedation and reduces atmospheric pollution.

3.2 Oral

Grade C
- The oral sedative agent should only be prescribed and administered by the operating dentist within the facility where the dental procedure is to take place.
- Children who are given an oral sedative should be placed in a quiet room facility together with their escort and a competent member of staff.
- Sedated children should be monitored clinically and electronically.

3.3 Intravenous conscious sedation

Grade C
- Intravenous sedation is not recommended in precooperative children. Dentists should consider whether the provision of an elective general anaesthetic might be preferable in such circumstances.
- Single drug intravenous sedation, e.g. midazolam, is recommended for adolescents who are psychologically and emotionally suitable.
- Intravenous sedation should only be administered by an experienced dental sedationist with a trained dental nurse in an appropriate facility.
- A pulse oximeter, at least, should be used to augment alert clinical observation.
- Intravenous sedation for children below the age of 14 years should be carried out in a hospital facility.
- Patient-controlled sedation may be of value for anxious adolescents.

3.4 Rectal

Grade C
- Rectal administration is not socially acceptable in the UK.
- It is currently not recommended outwith a hospital facility and requires the assistance of a qualified anaesthetist.

3.5 Intramuscular sedation

Grade C
- This is not recommended.
- Operators should consider whether the alternative provision of a general anaesthetic might carry a lower risk and give greater long-term psychological benefit to the child.

4.0 Polypharmacy

Grade B
- The use of multiple drugs increases the risk of complication and is not recommended.

5.0 Complications during paediatric dental conscious sedation

Grade C

- Complications can include respiratory depression, nausea, hypoxia, hyperactivity and unintentional loss of consciousness.

6.0 Monitoring

Grade C

Monitoring is the continuous observation of data from specific organ systems to evaluate the status of physiological function [8].

- Alert clinical monitoring is essential at all times.
- It is vital that adequately trained staff and the appropriate monitoring facilities are available to alert the operator if the patient undergoes desaturation.
- Electronic monitoring is not required in nitrous oxide inhalation sedation.
- A *minimum* of pulse oximetry is an essential requirement for all other types of sedation.

7.0 General anaesthesia

Grade C

- For pre-cooperative children, general anaesthesia remains the preferred method of providing dental treatment and may carry less risk and psychological trauma than inadequate or over-sedation.

Explanatory notes

2.1 Nitrous oxide inhalation sedation

Nitrous oxide gas has a sweet odour, which is pleasant to inhale and non-irritant. It has low tissue solubility and a minimum alveolar concentration (MAC) value in excess of one atmosphere, rendering full anaesthesia without hypoxaemia impossible at normal atmospheric air pressure. Poor tissue solubility ensures its effect is characterized by rapid onset and fast recovery [9].

2.1.1

Nitrous oxide inhalation sedation offsets the increase in pulse and blood pressure that is related to increased anxiety and facilitates coping across sequential visits, although some extremely anxious children may refuse to accept the nasal mask. It is a viable and cost-effective alternative to general anaesthesia for children undergoing dental extractions, especially elective premolar orthodontic extractions, with the exception of very young children, those who require multiple extractions and irregular attenders [10–20].

2.1.2

Nitrous oxide sedation has minimal effect on cardiovascular and respiratory function and the laryngeal reflex [10,21,22]. However, using nitrous oxide inhalation sedation in conjunction with other sedatives may rapidly produce a state of deep sedation or general anaesthesia. Nitrous oxide should be used with caution on ASA 3 and ASA 4 status patients, for whom it would be more appropriate to administer sedation in a hospital environment supported by a consultant anaesthetist [23].

2.1.3 Nitrous oxide pollution

Exposure to nitrous oxide can result in depression of vitamin B12 activity resulting in impaired synthesis of RNA. Dental surgeons and their staff are particularly at risk as they are exposed to high concentrations in the confined space of a dental surgery, especially if scavenging is inadequate [6,24–32].

2.1.4 Other inhalational agents

Isoflurane

Isoflurane is more potent than nitrous oxide. It has an ethereal odour and subanaesthetic concentrations reportedly produce rapid induction and amnesia without any significant cardiac or respiratory impairment [33–35] but its use as a sedative has not been thoroughly investigated in children. Isoflurane may irritate infant airways.

Sevoflurane

Sevoflurane has been reported as a sedative in children undergoing dental treatment [36] and as a deep sedative for wisdom teeth extraction [37]. There may be a theoretical risk of nephrotoxicity [38]. The technique is still experimental and should not be used in primary care dental practice until further research emerges.

2.2 Diazepam & temazepam

The benzodiazepines have been extensively used by both the medical and dental professions on account of their characteristic ability to act as anxiolytic, hypnotic, anticonvulsant and muscle relaxant drugs

which produce an anterograde amnesia [39,40]. Whilst the drugs are valued for pre-medication, their sedative effect in children is more variable.

2.2.1 Oral temazepam

Oral temazepam, administered as an elixir or gelatinous capsule has been reported to provide successful sedation for both anxious adults [42,43] and children [44,45]. Unfortunately, drug addicts who extracted the drug from the 'jellies' to inject intravenously abused the use of the gelatinous capsule, which is no longer available.

2.2.2 Rectal diazepam

Rectal administration of a solution of diazepam reaches peak serum levels in approximately 10 min [46]. Flaitz *et al*. (1985) using this technique to facilitate restorative care on 2–6-year-old children, reported it to be effective, predictable and safe [47]. Whilst Jensen and Schroder (1998) suggested that the resultant amnesia facilitated better behaviour and acceptance of dental care in 4–6-year-old children who had undergone local anaesthetic extraction of traumatized primary incisor teeth [48].

2.2.3 Intravenous diazepam

Healy and Hamilton (1971) reported that the protective laryngeal reflex was lost when IV diazepam was used to sedate anxious children [49]. The use of IV diazepam has been superseded by the introduction of midazolam.

2.3 Midazolam

Pharmacological agents such as erythromycin, some calcium channel blockers and antifungals can inhibit midazolam metabolism, resulting in a more profound or lengthier sedative effect [7]. Midazolam, known generically as imidazobenzodiazepine, has a high affinity for the benzodiazepine receptor (almost double that of diazepam). Unlike diazepam, the basicity of the molecule allows stable water-soluble salts to be formulated. High lipophilicity at physiological pH and very high metabolic clearance and elimination allow rapidity of onset and speedy recovery. Termination of action is by redistribution to peripheral tissues and by biotransformation [50,51]. Midazolam has a more rapid onset and recovery and produces a greater degree of amnesia than diazepam in dental patients [50–53] although it can cause hallucinations in children [54].

2.3.1 IV midazolam

Whilst the use of IV midazolam has been widely reported in adults, there are few studies to support its routine use in the dental management of anxious children. Mixing midazolam and fentanyl for intravenous use has led to respiratory arrest in a child [55].

2.3.2 Oral midazolam

Studies have produced conflicting results and are further confounded by the use of restraints and cosedatives [56–61]. Oral midazolam reaches the systemic circulation via the portal circulation, this decreases the drug's bioavailability, necessitating a higher oral dosage compared to intravenous administration [52]. Midazolam is now available in hospitals in a blackcurrant flavoured solution. Previously, '*crucial problems arose with administration of* (IV formulation) *oral midazolam due to its unpleasant taste*' despite it having been '*dissolved in a favourite beverage*' [60], such as a cherry elixir [52,57,62].

2.3.3 Intranasal midazolam

Intranasal administration of midazolam produces a sedative effect within 5 min of administration [63]. Studies using intranasal midazolam in paediatric dental patients are few in number and have involved few subjects but have shown that amnesia can be induced [61,64]. The administered dose is limited by the volume of the solution, as large volumes can cause coughing, sneezing and expulsion of part of the drug [52,62]. There have been reports of occasional respiratory depression and transient burning discomfort effecting the nasal mucosa [59,65].

2.3.4 Rectal midazolam

Krafft *et al*. (1993) reported that rectal midazolam had a short duration of onset, required a low dosage and was easily administered [60]. However, adverse reactions such as agitation, excitement, restlessness and disorientation together with significantly reduced blood oxygen levels, nausea and vomiting have been reported and '*advanced airway management proficiency is recommended*' [66–69]. Indeed, the use of this technique is likely to result in a level of sedation that is unacceptable in the United Kingdom.

2.3.5 Intramuscular midazolam

Downs *et al*. (1997) reported that children sedated using IM midazolam cried continuously throughout the procedure, despite the addition of nitrous oxide, and did not even benefit from amnesia [70].

2.4 Flumazenil

Flumazenil reverses all the effects of benzodiazepines. The duration of action of Flumazenil is 15–140 min and is dose dependent. The half-life of the antagonist is shorter than midazolam, which may lead to resedation, and post-op anxiety can occur unless it is carefully titrated. Therefore, whilst Flumazenil renders midazolam a safer agent for induction of anaesthesia, conscious sedation and IV infusion [71–78], routine reversal is not recommended as part of the conscious sedation technique.

2.5 Chloral hydrate, hydroxyzine and promethazine hydrochlorate and pethidine

2.5.1 Chloral hydrate

Chloral hydrate is a chlorinated derivative of ethyl alcohol that can act as an anaesthetic when administered in high doses. It is a weak analgesic and psychosedative with an elimination half-life of approximately 8 h. In small doses, mild sedation occurs and, in intermediate doses, natural sleep is produced. Although chloral hydrate has enjoyed widespread use as a paediatric sedative agent for many years it can be ineffective in the management of the refractory child due to variable absorption and partial inactivation in the hepatic portal circulation [79]. Moreover, chloral hydrate depresses blood pressure and respiratory rate and may cause oxygen desaturation [80] and prolonged drowsiness [81]. Nausea and vomiting are also common complications, attributable to gastric irritation. In larger doses, myocardial depression and arrhythmia can occur. The addition of nitrous oxide resulted in 27% of children losing control of their airway [82]. Chloral hydrate is contraindicated in children with heart disease as well as those with renal or hepatic impairment. Recently there has been concern that there is a risk of carcinogenesis, especially when used repeatedly [83]. It is rapidly becoming obsolete as a sedative agent in paediatric dentistry.

2.5.2 Hydroxyzine hydrochloride and promethazine hydrochloride

Hydroxyzine hydrochloride and Promethazine hydrochloride are psychosedatives with an antihistaminic, antiemetic and antispasmodic effect. Common side-effects are dry mouth, fever and skin rash.

Hydroxyzine hydrochloride is a diphenylmethane which is usually given orally or intramuscularly, singly or in combination with chloral hydrate. Avelos-Arenas *et al*. (1998) reported high rates of oxygen desaturation when chloral hydrate-hydroxyzine hydrochloride combinations were used and suggested that the combination was most effective when deep sedation was produced [84]. Indeed, the addition of hydroxyzine resulted in 21% of children experiencing at least one episode of oxygen desaturation below 95% [85].

Promethazine hydrochloride is a phenothiazine derivative and as such is a potent tranquillising agent that will potentiate the respiratory depressant effect of narcotics, barbiturates and other antihistamines.

2.5.3 Pethidine

Pethidine has been reported to cause nausea, vomiting and oxygen desaturation [86].

Evidence to support the single use of Hydroxyzine Hydrochlorate, Promethazine Hydrochlorate or Pethidine is poor. Their use should be restricted to the hospital environment.

2.6 Common anaesthetic agents that can also be used as sedatives

2.6.1 Propofol

Propofol (Diprivan: 2,6 di-isopropophenol) is a fast acting sedative with a narrower margin of safety than some other agents, i.e. the dose required to produce a sedative effect is close to that used to induce anaesthesia. Infusion pumps are used to control the dose, and patient controlled systems are currently in development, which have been used with some success in adult patients [87–93]. Veerkamp *et al*. (1997) published an account of an exploratory study where children, mainly with nursing bottle caries, had teeth removed using propofol administered by an anaesthetist. The authors reported that conscious sedation was difficult to achieve in this age group and recommended further investigation [94]. Furthermore, the use of propofol to sedate children in intensive care units has lead to severe adverse reactions, related to hyperlipidaemia [95]. It is therefore recommended that the use of propofol in children should be regarded as experimental and as such confined to hospital facilities with the assistance of a qualified anaesthetist until further research evidence emerges in this population.

2.6.2 Ketamine

Ketamine is a powerful analgesic, which, in small dosages, can produce a state of dissociation whilst

maintaining the protective reflexes. Side-effects include hypertension, vivid hallucinations and physical movement although these are less prevalent in children [9]. Ketamine is also known to increase secretions, including salivation, increasing the risk of laryngospasm [23,54,68,96]. Reinemer *et al*. (1996) found that the combination of a benzodiazepine with ketamine resulted in a statistically significant increase in blood pressure, heart rate and a fall in oxygen saturation [97]. As such, advanced airway proficiency was recommended [54]. This drug is not recommended for use in paediatric dental sedation.

3.0 Routes of administration

3.1 Inhalation

The inhalation sedation technique that is commonly used in dentistry refers to the administration of a titrated dose of nitrous oxide in oxygen. In this respect, the technique is different from the Entonox (50 : 50 oxygen and nitrous oxide mixture) that is administered in maternity or medical A & E units. Only dedicated dental nitrous oxide inhalation sedation delivery systems must be used. The standard delivery system is designed to prevent administration of nitrous oxide gas concentrations in excess of 70%, i.e. there is an assured minimum oxygen concentration of 30%. There should be a fail-safe device which shuts down nitrous oxide delivery should the oxygen supply fail. The dentist sets the flow depending on the calculated tidal volume of the patient and then uses a single valve to vary the percentage delivery of nitrous oxide against oxygen. Meanwhile, the dentist should encourage relaxation through semi-hypnotic suggestion and reassurance as the psychological preparation by the operator exerts a beneficial influence on the analgesic effect of the gas [98].

3.2 Oral

Oral agents have a slower and more variable onset of action and depth of sedation than sedatives administered by other routes. Compared to other routes, onset of sedation is prolonged and duration of action is unpredictable due to variable gastric absorption. Despite this, Nathan (1989), in a survey of USA pedodontists, reported that this was the preferred route even for difficult paediatric dental patients [1], even although children may spit out the dose [59], leaving the clinician uncertain of the exact dose administered. Some sedationists prefer to use a (needleless) syringe placed in the buccal sulcus behind the teeth or to mix the drug with a flavoured elixir.

3.3 Intravenous sedation

The majority of studies where intravenous sedation was performed have used adults, many of whom were undergoing third molar surgery, as the study sample. The very few studies that reported the use of intravenous sedation in children have used multiple drugs and have produced a deeper level of sedation than is acceptable in the UK, and they have therefore been excluded from this paper. Indeed, even paediatric dentists in the USA, who have deep sedation techniques available, may prefer general anaesthesia over parenteral sedation in their private (non-hospital) practices [1,99–101].

3.4 Rectal route

Although the rectal route has been reported to be effective, predictable and safe, especially in relation to diazepam [40,47], this route has not found widespread acceptance in paediatric dental practice in the UK, probably because an enema is required.

3.5 Intramuscular

Intramuscular administration of sedative agents is reliable but painful and was mainly used in the UK prior to induction of general anaesthesia. It is not recommended for paediatric dental management [23,102].

4.0 Polypharmacy

The use of drug combinations or premixed drug cocktails is generally best avoided because of the increased risk of side-effects [23,103–105]. Respiratory depression is more likely to occur when more that one sedative agent is administered. Milgrom *et al*. reported that 63% of their anxious young adult study group, sedated with a midazolam-fentanyl combination, suffered from apnoea (cessation of breathing) [106]. Barr and Wynn (1992) reported that 37% of children sedated with ketamine and fentanyl had either nausea or vomiting [107]. In a more recent study, almost 40% of children sedated with a combination of chloral hydrate, hydroxyzine and pethidine suffered from apnoea [108].

5.0 Complications during paediatric conscious sedation

The main complications related to paediatric conscious sedation are hypoxia, nausea and vomiting and inadvertent general anaesthesia (over sedation). Morbidity and mortality increases in the extremes of age and with worsening ASA classification [109]. Sams *et al*. (1992), in a retrospective review of case notes, reported that 48% of children had oxygen desaturation while sedated for dental treatment [110]. Even although relatively few papers report over-sedation or other adverse effects in paediatric dentistry, such complications are not uncommon [104,111]. Indeed, even the use of a mouth prop can misguide the sedationist leading to over-sedation.

The interpretation of the level of sedation in literature published outside the UK, especially in relation to the GDC definition, is often difficult. In the USA, the different levels of sedation are linked to mandatory levels of monitoring, facilities and expertise [112]. However, despite this, a critical incident analysis of paediatric (medical and dental) sedation suggested that permanent neurological injury or death occurred most frequently in non-hospital-based facilities [104].

6.0 Monitoring

Although the principal functions monitored are the central nervous, cardiovascular and respiratory systems, hypoxaemia is the major complication in the sedation of paediatric dental patients.

Hypoxaemia is defined as a low partial pressure of oxygen in the blood, which may be caused by conditions such as failure of oxygen supply, pulmonary disease, cardiovascular collapse, hyperventilation, apnoea or airway obstruction. Traditional methods of monitoring sedated paediatric patients include visual observation of skin colour, depth and rate of respiration, measuring pulse and blood pressure and listening to heart and breath sounds using a pre-cordial stethoscope. Moore *et al*. (1984) described a method of determining the level of consciousness in a sedated child in which the head was allowed to drop forward onto the chest while an observer listened for breath sounds [82].

Trained personnel skilled in conscious sedation are vital to monitor the safety and well-being of the sedated child dental patient. However, hypoxaemia can occur before changes in vital signs or skin and mucosal colour are detectable and symptoms may not become clinically evident until dangerously low levels of oxygen tension develop [113].

6.1 Pulse oximetry

Pulse oximetry has revolutionized modern monitoring procedures. It is a non-invasive method of measuring arterial oxygen saturation using a sensor probe, placed on the patient's finger or ear-lobe, which has a red light source to detect the relative difference in the absorption of light between saturated and desaturated haemoglobin during arterial pulsation. Adequate oxygenation of the tissues occurs above 95%, whereas oxygen saturations lower than this are considered to be hypoxaemic. Under normal circumstances, a child's oxygen saturation (SaO_2) is 97–100%.

The probe is sensitive to patient movement, relative hypothermia, ambient light and abnormal haemoglobinaemias, which means that false readings can occur. Indeed, the role of carbon dioxide monitoring (capnography), as an adjunct to pulse oximetry and alert clinical observation, is under increasing scrutiny [8,114–116].

7.0 General anaesthesia

Whenever the level of sedation is found to be inadequate the planned procedure should be abandoned. An elective general anaesthetic is safer than topping up the sedative dose, even when this is done with extreme care [23].

Author's note

Reference to the dosage of the various drugs mentioned, with the exception of nitrous oxide, has been deliberately excluded, as it was not my intention to have this guideline used as a 'recipe book' for conscious sedation of children. I am happy to give further advice or information on request.

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