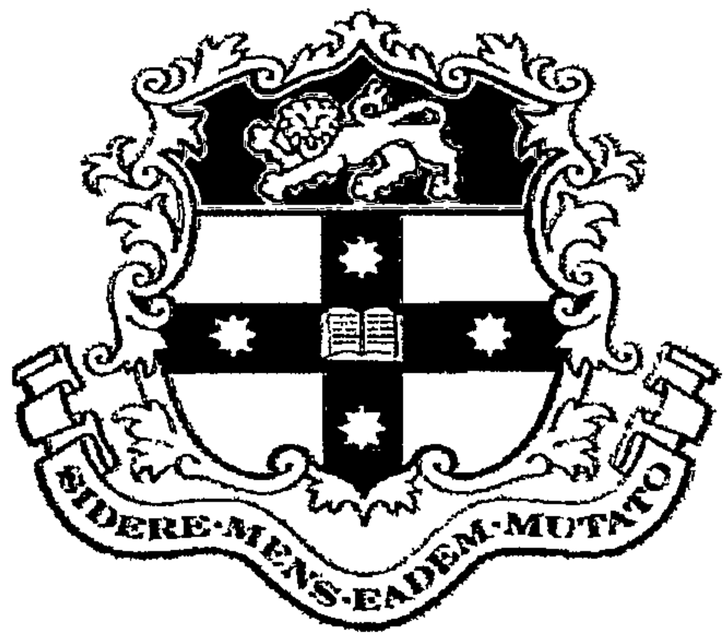

The Demand for Dental General Anaesthesia in Children at Westmead Hospital, Sydney, Australia

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ABSTRACT

The demand for dental general anaesthesia in children at Westmead Hospital, Sydney, Australia.

The use of general anaesthesia (GA) to provide dental treatment for children has been reported for several decades. The aim of this study was to assess demographic factors and nature of treatment provided for children treated under GA at Westmead Hospital. Randomized samples of patients from 1984 and 1996 were selected and data collated in a retrospective manner; information such as age, suburb of residence, waiting list time, reason and source of referral, ethnicity and treatment provided were recorded. The data was analysed using T-tests and Chi-square tests. Results showed that certain populations of Sydney provide greater number of children requiring GA services. There was a steady increase in the demand for this service, from a total of 212 children in 1984 to 777 in 1996. Dental caries was the main reason for referral, with an increase from 70% in 1984 to 83% in 1996 ($p<0.05$), with over two thirds of the children being under 6 years of age. The ethnicity of these children has changed over the 12-year period, with more Asian and Middle Eastern children being treated in 1996. Self referred/emergency patients, general practitioner dentists, and The School Dental Service were the main sources of referrals. The nature of treatment has changed significantly with 20% more primary teeth being extracted in 1996 than in 1984. The mean waiting time increased from 37 to 80 days in the 12-year period, indicating that the demand has outstripped its provision. The increase in demand for GA services may be attributed to: changes in pattern of caries distribution, changes in demographics, increased restrictions for GA services in the private sector, and changes in the public dental services. Despite a general decline in caries in Australia, nursing and rampant decay still remain a significant problem in certain communities within Sydney. The demand for dental treatment under general anaesthesia has increased over the past two decades with caries remaining the main reason for use of this service.

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Chapter 1 . LITERATURE REVIEW

Introduction

The main topic of discussion of this literature review is the use of general anaesthesia (GA) in paediatric dentistry. The use of this technique in paediatric dentistry is one of many when dealing with the very young, the medically compromised or any child unable to receive treatment in a more conventional way. The use of general anaesthesia however has remained controversial over the years as many clinicians have felt that dental treatment does not justify the use of GA due to its inherent risks. Nonetheless, this technique has been used routinely and successfully for several decades.

Before addressing the history, development, safety and current use of GA in children, this literature review will address briefly the question of why general anaesthesia is needed in paediatric dentistry. It will do this by reviewing the aetiology and factors that influence behaviour and fear, and then review current knowledge and the efficacy of alternative methods of managing children.

The second section of this review deals with several aspects of general anaesthesia. The history and development of anaesthesia help us understand how GA has evolved over time. It also highlights the origins of day-stay surgery and how it developed in dentistry. Safety of GA is included, as mortality and morbidity are the major objections to its use in dentistry. A brief description of the drugs and monitoring devices currently used in general anaesthesia has been included to highlight the most commonly used drugs and techniques available. In addition, this section discusses special considerations that apply to children undergoing GA such as anatomical, physiological and psychological differences as compared to adults. A

brief discussion of the current guidelines and regulations that dictate how GA is practiced in NSW is also addressed.

The third section reviews the literature on the use of GA in paediatric dentistry. As the characteristics of these studies varies considerably, a summary of the most relevant information is given in order to compare and analyse the findings of this study with others around the world.

The last section describes the delivery of paediatric dental services in NSW. A description of the oral health of children in Australia is given. Who provides dental care to children in the state of NSW is briefly discussed. Westmead Hospital is the main provider of paediatric dental GA services in the state and the location of this study. A description of the Paediatric Dentistry Unit and the day-stay GA unit is therefore given. This allows a better understanding of the delivery of services at Westmead Hospital, an insight into the structure and functioning of the GA unit, and an appreciation of the demand for paediatric dental general anaesthesia at this hospital.

Management of the paediatric patient

The genesis of Paediatric Dentistry is due to the dental and orofacial problems that affect children. Undoubtedly, the most common problems are related to dental caries, pulpitis, and the inflammation and pain associated with infected pulpal tissue and suppuration in alveolar bone (Pinkham, 1994).

Paediatric Dentistry, as a body of knowledge and as a clinical discipline, has borrowed heavily from other specialty areas in dentistry. In addition to this knowledge, a clinician that handles children must know certain basics in paediatric medicine, general and oral pathology, and growth and development. Knowledge of nutrition and an understanding of both systemic and topical fluorides are also essential in the development of appropriate prevention strategies for the child patient (Pinkham, 1994).

The successful management of children requires an understanding of their emotional and psychological needs as well as their processes of emotional change and social maturation. The child has to be managed differently than the adult and, in fact, the modes of management are extremely age related (Pinkham, 1994). Without doubt, the effective and sympathetic management of pain and the associated anxiety is central to the practice of paediatric dentistry. A major difficulty for paediatric dentists is the varied responses of children of widely different ages to painful stimuli (Roberts, 1997). Infants up to about 2 years of age are unable to distinguish between pressure and pain. After the age of approximately 2 and up to the age of 10, children begin to have some understanding of "hurt" and begin to distinguish it from pressure or "a heavy push". The problem is that it is difficult to identify those children who are amenable to explanation and respond by being cooperative when challenged with local anaesthesia and dental treatment (Roberts, 1997). Children over the age of 10 are much more likely to be able to think abstractly and participate more actively in the decision to use local anaesthesia, sedation, or general

anaesthesia. Indeed as children enter their teenage years they are rapidly becoming more like adults, and are able to determine more directly whether or not a particular method of pain control will be used (Roberts, 1997).

Behaviour and Dentistry

The behaviour of children in the dental environment is one of the most difficult aspects when treating young patients. Anxious children demand considerable time, effort, and clinical expertise from the operator. While the vast majority of young children can readily accept dental care, there are many for whom dentistry can be difficult. The majority of young children have very little idea of what dental treatment involves and this will raise anxiety levels. Most children will cope if given friendly reassurance from the dentist, but some patients will need a more structured programme (Roberts, 1997). This section will address the behaviour of children in the dental clinic and how dentists behave and respond to the different demands imposed by children. The behaviour of parents towards dentistry is discussed, and how this influence may alter the interaction between dentist and child.

Perceptions and Behaviour of Children

Fear of dentistry is a common problem for patients and dentists. Very often this fear of dentistry stems from a bad experience in childhood. Fear is also rated as the principal management problem encountered by dentists and is implicated as an important factor in broken or cancelled appointments (Murray and Niven, 1992).

Fear of dental treatment, resulting from painful experiences and learning from others, has been shown to be a major factor in children not seeking dental care in both Finland and the United States (Alvesalo et al. 1993; Murtomaa et al. 1996). Such fear is particularly associated with injections and drilling when treating children. Poor dental experience in

childhood may also be associated with lower rates of utilisation among adults (Alvesalo et al. 1993). For these reasons, it is important to ensure that the dental experiences of children are as painless as possible. A scared child confronted by a dentist can be either fearful or anxious. The child may fear something specific such as an injection, or may be anxious about what the dentist intends to do, without any knowledge of the planned procedure. The level of fear can vary from mild apprehension, which can be overcome by a calm and reassuring approach, to abject terror, which prevents any dental work from being carried out without recourse to a general anaesthetic (Murray and Niven, 1992).

Sedation and general anaesthesia are indicated when treating uncooperative or unmanageable children, rather than subjecting them to stressful visits. It has been shown that children become increasingly sensitised to repeated stressful procedures, and this is accompanied with decreased cooperative behaviour (Venham and Quatrocelli, 1977). The behavioural changes of children undergoing dental treatment using oral sedation versus general anaesthesia have been described previously (Camm et al. 1987). It was noted that children who received dental treatment with oral sedation underwent behavioural changes similar to those children who received dental treatment with general anaesthesia. According to their mothers, both groups exhibited postoperative behavioural changes (within a 7-day post-operative period) not seen by children receiving routine dental treatment (Camm et al. 1987).

Perceptions and Behaviour of Dentists

It is evident that dentist behaviour can affect a child's perception of dentistry and that this perception is variable in the genesis of dental anxiety. There have been some studies that have concentrated on the interface between child and dentist behaviour within the dental surgery (Alwin et al. 1994; Weinstein et al. 1982).

It has been suggested that the response of a dentist to a child's fear related behaviour is based more on the dentist's own personality than on established management techniques. The highest probability of reducing fear related behaviour are methods such as giving direction, reinforcement, and questioning for feeling (Weinstein et al. 1982). A similar study from the U.K. found that dentists changed their behaviour when dealing with anxious children (Alwin et al. 1994). Dentists adopted some, but not all, of the anxiety management techniques that have been found in previous studies to reduce stress of dentally anxious children.

The perception of pain experienced by children is often uncertain. Health professionals who control whether or not child patients receive medication or anaesthesia are responsible for estimating the level of pain felt by these children. Health professionals often hold misconceptions about children's pain and tend to underestimate it clinically. A recent survey of Finnish and American dentists found more similarities than differences between these two groups of dentists. Both groups rated the pain associated with dental treatment at about the same level, but they seemed to underestimate the pain and unpleasantness of dental treatment (Murtomaa et al. 1996). This finding has also been reported previously (Milgrom et al. 1994). Interestingly, there was little relationship between perceptions and management of pain. Dentists who rated treatment as more unpleasant were more likely to question children about pain. On the other hand, the dentist's perception of a child's pain appeared unrelated to the use of anaesthetics, which presumably may result in many dentists providing inadequate pain control (Murtomaa et al. 1996). Alwin and coworkers reported the incidents that parents think might have contributed to dental fear. Parents of anxious children were able to cite a specific incident in 75% of cases. The most common incident was dentist manner, followed by general anaesthetic, fear of needles, extractions, and 'drilling and filling' (Alwin et al. 1991).

There appear to be substantial differences between the way dentists and patients perceive pain and pain management, and how ethnic backgrounds affect pain description. This may affect how patients are treated and, thus, their future likelihood of seeking dental care (Murtomaa et al. 1996; Moore et al. 1986). A study assessing cultural perceptions of pain indicated that ethnicity may play a stronger role in the perceptions of pain description than does professional socialisation. This last term is defined as the process whereby standards for what exists, what goals are to be valued, and how one should behave are learned by a mutually identified group of individuals within an occupation (Moore et al. 1986).

Although all dentists use child management techniques, paediatric dentists receive additional training and experience. Factors such as sedation guidelines, informed consent requirements, variation in state dental practice acts and professional liability insurance may affect the use of management procedures (McKnight Hanes et al. 1993). Surveys from American studies show that paediatric dentists employ a broader spectrum of management techniques as compared to general dentists; also, there are variations in dentist's age and area of practice (McKnight Hanes et al. 1994; McKnight Hanes et al. 1993). Furthermore, paediatric dentists perceive that they treat younger patients, more handicapped patients, more behaviour problems, and more children that require general anaesthesia than general dentists do.

Parental Attitudes

Parental attitudes in general, and towards dentistry in particular, have a profound influence on a child's behaviour. Factors thought to be important include the age of the parents and their level of maturity. Positive dental attitudes in parents will create an environment for the child that is compatible to the acceptance of good dentistry (Malamed, 1995j). The parent's prior experience with medical and dental health professionals will greatly influence their child attitudes. Although few parents would tell their children of prior traumatic experiences they have had, such attitudes and feelings may be transferred to the child via nonverbal

communication (Malamed, 1995j). There is no general consensus among dentists whether a parent should be permitted in the surgery, but trends reveal increased parental presence and involvement in decision-making and provision of care (Nathan, 1989).

The presence of parents in the surgery should be agreed upon mutually, with the child's best interests in mind. The need to spend time to eliminate the parent's fears and provide counselling with respect to the parent's role and expectations are essential to the overall management plan for child and parent alike (Nathan, 1989). Parental attitudes must be taken into account when considering the use of sedation; however, the clinician must always make the final decision. There is evidence that parents, especially mothers, suffer more stress and anxiety while their children are treated under sedation or GA than mothers whose children received routine dental care (Camm et al. 1987).

Management of pain and anxiety in children

The different methods of pain control in dentistry for children vary from simple behaviour management to full intubation general anaesthesia in a hospital operating theatre. In general terms, there are two main methods by which children are treated in dentistry: pharmacological and non-pharmacological. Non-pharmacological methods refer to techniques that deal with behaviour management and hypnosis (Shaw and Niven, 1996b; Gokli et al. 1994), whereas pharmacological methods could be subdivided into:

1. Local Anaesthesia
2. Relative Analgesia (Inhalational sedation)
3. Other forms of Sedation
4. General Anaesthesia

Behaviour Management of Children

Considerable efforts have been directed toward the development and assessment of various strategies to manage the difficult manifestations of dental fear and anxiety in children. Nonetheless, it is equally important to the dental profession to investigate how to prevent or intercept dental fear at the outset. Fearful children demand considerable time, dedication, and expertise from the dental team. Therefore, it is imperative that dental experiences be favourable if the profession is to help the public maintain oral health, and seek periodic preventive as well as restorative care (Weinstein and Nathan, 1988). Although childhood fear is normal and healthy, fears may persist and produce profound disabilities. Dental fear, whether learned as a consequence of aversive child management practices or through negative expectations from others, may set the stage for traumatic dental experiences and/or subsequent avoidance of needed dental treatment. The long-term consequences may influence health, appearance and general welfare (Weinstein and Nathan, 1988).

There is a strong correlation between the perception of pain experienced and the degree of anxiety perceived by the patient. Painful procedures cause fear and anxiety; fear and anxiety intensify pain. This circle of cause and effect is central to the management of all patients. Good behaviour management reduces anxiety, which in turn reduces the perceived intensity of pain, which further reduces the experience of anxiety (Roberts, 1997). Dentistry should be seen as a stressful experience that mobilises the child's existing coping abilities. The outcome of this experience is determined not only by the child's particular expression of fear and coping, but also by the clinician's choice of appropriate management strategies and his/her desire to successfully treat the child and not just the dental problem. It is important to note that the use of some management strategies may result in temporary cooperation at the cost of intensifying fears or phobias. On the other hand, successful management of dental fear may not only result in better future dental outcomes, but may enhance the ability of the child to cope with other fearsome situations (Weinstein and Nathan, 1988).

One of the objectives of using management control techniques is to achieve positive behaviour not only short term but also to create a positive dental attitude as the child gets older. A Swedish study investigated 146 children with dental fear, aged 3 to 13 years, regarding how they accepted dental treatment after five years. Caries incidence was high in 71% of the patients. Conventional treatment was given in 48%, 25% needed conscious sedation, and 27%, were treated under general anaesthesia. After five years, 78% of the children showed good acceptance of conventional dental treatment while 18% received conscious sedation and 4% general anaesthesia. Good cooperation was seen significantly more often in children referred at the age of 3- 8 years than when referred at an older age. Good acceptance was also found significantly more often when conventional treatment had been given (Varpio and Wellfelt, 1991).

Familiarisation of the patient to the dental environment and the allowance of enough time for the child to feel comfortable, are important steps familiar to the paediatric dentist. Recognised behavioural methods for reducing fear and pain sensitivity are summarised in Table 1.1 (Cameron and Widmer, 1997).

Tell-Show-Do	Informing, then demonstrating, and finally performing part of a procedure.
Playful Humour	Using fun labels and suggesting use of imagination.
Distraction	Ignoring and then directing attention away from a behaviour, thought, or feeling to something else.
Positive Reinforcement	Tangible or social reward in response to a desired behaviour.
Modeling	Providing an example or demonstration about how to do.
Shaping	Successive approximations to a desired behaviour.
Fading	Providing external means to promote positive behaviour and then gradually removing the external control.
Systematic Desensitisation	Reducing anxiety by first presenting an object or situation that evokes little fear, then progressively introducing stimuli that are more fear provoking.

Table 1.1: Behavioural methods for reducing anxiety in children

The use of aversive techniques such as physical restraint devices and hand-over-mouth technique is controversial. A survey of American paediatric dentists found that the need for some form of physical restraint was low (4%). There was a tendency to limit the application of restraining devices (pedi-wrap, papoose board) to either handicapped or sedated patients for the purpose of preventing potentially harmful reflex movements (Nathan, 1989). The use of the Hand-over-mouth technique (Levitas, 1974; Craig, 1971) has become controversial on the basis of perceived harshness, lack of informed consent and possible issues of assault. In recent years, paediatric dentists and other health professionals have developed a greater interest in the issue of informed consent largely due to an increase in malpractice litigation and ever-escalating cost of liability insurance. The use of control techniques that carry the potential for misuse (hard restraints, hand-over-mouth, sedation and general anaesthesia) require the practitioner to obtain the informed consent from the legal guardian, and also to be able to produce written evidence of this consent (Nathan, 1989; Klein, 1991; St.Clair, 1995).

Wright and coworkers investigated particular behavioural and pharmacological techniques used by a sample of Australian dentists (219 general dentists and 48 members of the Australian Society of Dentistry for Children) to deal with children's anxiety and behaviour. The management strategies and their frequency of use, derived from answers to a questionnaire were as follows: allow child to raise a hand or similar to stop treatment (79%); furnish toys in the waiting area (72%); use of behavioural methods such as positive reinforcement and coaxing (68%); use of Tell-Show-Do (60%); let child hold toys and mirror during treatment (52%); and offer child reward after appointment (51%). In contrast, the most frequent unpopular strategies were: the use of TV or tapes during treatment (86%); film or video modeling (85%); hypnosis (83%); and Hand-over-mouth technique (74%) (Wright et al. 1991b). The authors concluded that 'paediatric dentists' would more frequently perform all forms of management strategies than general dentists, and that younger dentists would be more likely to use behavioural management techniques than older dentists. When comparing Australian with North American and British strategies, the

authors noted similarities between Australian and British dentists. North American dentists tended to use hand-over-mouth as a common strategy, whereas Australian and British dentists had a higher rate of using general anaesthesia. Rather surprisingly the use of relative analgesia, hardly featured at all in this study and was relegated to the category of 'other strategy' (Wright et al. 1991b).

Local Anaesthesia

Pain management is an essential skill for health care providers. In recent years, new information has revolutionised approaches to pain control. The traditional concept that pain is directly proportional to the nature and extent of the injury is no longer accepted. Rather, considerable evidence documents inadequate management of children's pain, primarily due to the dentist refusal to provide analgesia (Milgrom et al. 1994). Outdated beliefs and mis-perceptions regarding children's pain are common among health professionals and need to be recognised and challenged. The reason for describing local anaesthesia is that many children find difficult to accept injections due to fear and anxiety, past negative experiences or pre-conditioning by others, and this may be a major reason why some children require GA. It is therefore important to highlight how this technique can be modified when dealing with children.

The use of local anaesthesia in routine dental treatment in children varies considerably around the world. A study from Finland highlighted differences between American and Finnish dentists in regards to the dentist's perception and management of pain in children (Murtomaa et al. 1996). Finnish dentists were much less likely to use local anaesthetics during restorative treatment of either primary or permanent teeth than USA dentists. Neither group of dentists routinely prescribed nitrous oxide sedation, or premedication, or post-operative pain medications. Regarding the dentists' perceptions of pain experienced by children during dental treatment, neither group rated dental treatment procedures as particularly painful or unpleasant. Most dentists found the pain reports of children credible,

yet a significant proportion (up to 67% of the USA dentists and 21% of the Finnish dentists) did not find them strongly credible (Murtomaa et al. 1996). Local anaesthesia therefore makes an important contribution to the management of pain in dentistry. A successful technique in children depends on the use of good topical anaesthesia, adequate local anaesthetic technique, and appropriate communication with the child. This approach to patient management must influence acceptability and success of local anaesthesia.

There are no techniques of local anaesthetic administration that are unique to children, however modifications to standard methods are sometimes required. These include proper positioning of the child, routine use of topical anaesthesia, slow injection, and avoidance of direct palatal injections among others. If there is a choice at which site to administer the first local anaesthetic injection, the primary maxillary molar area should be chosen first. This region is the most easily anaesthetised with the least discomfort.

The administration of pain-free local anaesthesia depends upon a number of factors that are controlled by the operator. The choice of syringe used for conventional local anaesthetic injections in children must allow aspiration both before and during the injection of the anaesthetic solution. There is evidence that inadvertent intravascular injection is more likely to occur in younger patients and positive aspirate incidences of 20% of inferior dental block injections in the 7-12 year age group have been reported (Meechan, 1997). A recent study evaluated the use of mandibular infiltration versus block anaesthesia in paediatric dentistry. This study concluded that buccal infiltration anaesthesia was effective in providing good anaesthesia for restorative work and extractions, when supplemented by interpapillary injections in mandibular primary molars regardless of age. Buccal infiltration proved effective for pulp treatment of primary first molars but not reliable in primary second molars. Finally, block anaesthesia was found to have a negative effect on the behaviour of children aged 3-5 years (Sharaf, 1997).

Inhalation Sedation: Relative Analgesia

Inhalation sedation (relative analgesia, RA or nitrous oxide/oxygen sedation) remains the most ideal technique of sedation in paediatric dentistry, with several studies supporting its use (Roberts, 1990a; Nathan et al. 1988; Shaw et al. 1996a). It is used in children that are basically cooperative but nervous or anxious about a specific thing such as local anaesthesia. Nitrous oxide (N_2O) is a non-irritating, sweet smelling, colourless gas. It is relatively insoluble in the blood and is carried in the blood in physical solution only, not combining with any blood elements (Malamed, 1995g).

Relative analgesia (RA) has many significant advantages over other forms of sedation. These can be summarised as follows:

- The onset of action of RA is more rapid than that of oral, rectal, and intramuscular (IM) sedation. The onset of action of intravenous (IV) sedation will be approximately equal to that of relative analgesia.
- Peak clinical effect does not develop in most techniques for a considerable time. Only RA and IV sedation provide peak clinical actions in a time span allowing titration:

Sedation Route	***Peak action time***
Oral	60 min
Rectal	60 min
IM	30 min
IV	60 sec-20 min
RA	3-5 min

- The depth of sedation achieved with RA may be altered, allowing the operator to increase or decrease the depth of sedation. This degree of control represents a significant safety feature of RA.
- Duration of the procedure can be altered at the discretion of the operator. This is different to the other forms of sedation, which have a relatively fixed duration of clinical activity.
- Recovery time from RA is rapid and the most complete of the sedation techniques. Because the body does not metabolise nitrous oxide (N_2O), the gas is rapidly and virtually completely eliminated from the body within 3 to 5 minutes.

The major difficulties with this technique in children are two-fold: first the lack of potency of N_2O/O_2 may render the technique ineffective in the management of the more apprehensive patient, and second, some children will object to the placement of the nasal mask. This is a major problem with some children and therefore some degree of cooperation is required for RA to be successful. The overwhelming majority of children receiving RA are adequately sedated at concentrations between 30% and 40% N_2O (Malamed, 1995c). Screaming and crying patients will breath through their mouth to a great degree and therefore do not receive as a great a volume of N_2O via the nasal mask. Malamed suggests holding the mask on the patient's mouth instead of the nose, so that the child inhales greater amounts of nitrous oxide (Malamed, 1995j).

One of the more unpleasant problems when using RA in children is vomiting. Although not frequent, the incidence of vomiting appears to be greater than that seen in adults, with reports quoting figures of 10.5% (Houck and Ripa, 1971) or less than 1% (Roberts, 1990b; Hallonsten et al. 1983). This is due to the lack of ability by the operator to judge the level of the patient's sedation, which may lead to over-sedation; and secondly, the greater tendency of children to mouth-breathe. Mouth breathing decreases the volume of N_2O being inhaled

and lessens the level of sedation. When the patient returns to nose breathing, the sedation level deepens. Constant fluctuation in N_2O concentration is one cause of vomiting. Two techniques are available that decrease mouth breathing. First, simplest and most effective is the use of rubber dam. It prevents mouth breathing almost entirely. A second technique, in the absence of rubber dam, is to ask the child to hold some 'special water' in their mouth (and they cannot swallow it). This raises the tongue against the palate, therefore eliminating mouth breathing (Malamed, 1995j).

In summary, RA is a highly successful method to treat anxious or difficult children. Success rates in children have been quoted at 87% (Crawford, 1990), 88% (Major et al. 1981) and 90% (Hallonsten et al. 1983; Shaw et al. 1996a).

Sedation: Other techniques

Sedation is defined as a state of depression of the central nervous system that reduces anxiety thus enabling treatment to be carried out satisfactorily. During sedation the patient is able to independently maintain his airway, the mouth open, and respond sensibly to verbal commands. In addition the patient maintains adequate function of protective reflexes such as the laryngeal reflex. The drugs used should carry a margin of safety sufficient to render unintended loss of consciousness extremely unlikely (Roberts, 1997). According to guidelines established by The American Academy of Pediatric Dentistry in 1985, patients for conscious sedation should be ASA classification I or II (see Appendix No.1). The ASA or American Society of Anesthesiologists groups each patient according to their physical status (Owens et al. 1978). Each patient should be evaluated for allergies, medications, diseases, disorders and previous hospitalisations (American Academy of Pediatric Dentistry, 1985). Economic considerations are also of importance in determining the nature of the sedative procedure to be employed. One reason for the increased use of outpatient sedation in dentistry (and medicine) has been the high cost of hospitalisation incurred by the use of GA (Malamed, 1995j). Sedation in paediatric dentistry has a failure rate considerably greater

than that seen in adults. Trapp has stated that a failure rate of 20% to 40% is not unusual in children (Trapp, 1982). More recent experience with paediatric sedation has demonstrated a 20% to 40% failure rate with oral sedation, but a 5% failure rate with IM/IV sedation (Malamed, 1995j). The routes of administration of sedative drugs of practical use in paediatric dentistry are:

i. Oral

ii. Rectal

iii. Intranasal

iv. Parenteral:

- Intravenous (IV)
- Intramuscular
- Subcutaneous
- Submucosal

Oral Sedation

In regards to sedation, oral drug administration is considered the route of choice in paediatric dentistry because of its high patient acceptability. A survey carried out in USA found that apart from inhalational sedation, oral sedation was still the most popular treatment modality chosen by clinicians to treat difficult children (Nathan, 1989). One of the major advantages of oral sedation is the fact that there is no need for the use of a needle (IM, IV) or a nasal mask (RA) to produce a clinical effect. Where appropriate, the parent may administer the drug at home prior to the dental visit (Yanase et al. 1996). This practice is however, somewhat controversial because there are cases on record in which the parent has inadvertently oversedated the child (Malamed, 1995j). Younger children may not tolerate tablets and capsules well; therefore many of the drugs administered to children are available as an elixir or syrup, which may prove more palatable to the patient. Drugs that have an unpleasant taste or odour may occasionally be mixed with food or liquids (Malamed, 1995j). Other disadvantages of the oral route include prolonged effect of the drug, reliance on

patient/parent cooperation, inability to titrate, incomplete absorption of drugs from the gastrointestinal tract, inability to readily lighten or deepen the level of sedation, and dietary restrictions (Malamed, 1995j; Sams et al. 1992).

In paediatric dentistry several drugs have been tried with varied results. This is due to the continued lack of consensus among paediatric dentists regarding the selection and dosage of drugs used for sedation (Duncan et al. 1983). A list of the most frequently used drugs is presented below:

- *Chloral hydrate:* This is a sedative drug that decreases anxiety by depression of the sensory cortex (Duncan et al. 1983). It has been used alone with a reported success rate of 85% in one study (Duncan et al. 1994), or in combination with promethazine (Phenergan) with 54% success (Sams et al. 1992), hydroxyzine, nitrous oxide/oxygen or meperidine (Duncan et al. 1983) with varied success.
- *Combination of pethidine* (also called meperidine, narcotic analgesic) *and promethazine* (antihistaminic), with success rates at 45% (Alfonzo Echeverri et al. 1993) and 63% (Sams et al. 1992).
- *Ketamine:* This is defined as a dissociative anaesthetic drug with a powerful analgesic effect. Ketamine is easy to administer, its onset is quick, there is a wide safety margin and exhibits a short duration of action. Success rates have been reported at 65% (Alfonzo Echeverri et al. 1993).
- *Hydroxyzine:* This is an antihistaminic with sedative and anti-emetic properties. It has been used alone (Kupietzky et al. 1996) or in combination with chloral hydrate to reduce the incidence of nausea and vomiting (Tsinidou et al. 1992).
- *Diazepam (Valium):* A benzodiazepine with anxiolytic, sedative, muscle relaxant and anticonvulsant effects (Houpt et al. 1996).
- *Temazepam:* A benzodiazepine and metabolite of diazepam with sedative and hypnotic effects (Tsinidou et al. 1992).

- *Midazolam (Hypnovel):* A short acting benzodiazepine with anxiolytic, sedative, hypnotic, anticonvulsant, muscle relaxant, and anterograde amnesic effects (Kupietzky and Houpt, 1993). Success rates of 67% (Hartgraves and Primosch, 1994), 75% (Krafft et al. 1993), and between 60% and 75% depending on the oral dose have been quoted (Silver et al. 1994).

Much interest has been focused on the use of midazolam for conscious sedation in paediatric dentistry. Midazolam has been used as a pre-anaesthetic sedative in adults and more recently in children (Kupietzky and Houpt, 1993). Midazolam is currently available in the US and Australia only as an IV solution. Given orally, the drug has a distinct bad taste that is not easily disguised in juices or other clear or carbonated soft drinks. Only 15-30% of an orally administered dose of midazolam reaches the systemic circulation in its non-metabolised form due to an extensive hepatic effect (Payne et al. 1989). Thus, the oral dose should be approximately double or triple the IV dose to achieve similar clinical effects. Oral doses ranging between 0.3-0.75 mg/kg are commonly recommended (Silver et al. 1994; Hartgraves and Primosch, 1994; Kupietzky and Houpt, 1993), and the medication should be given 20-30 minutes prior to treatment.

A variety of studies have evaluated paediatric dental sedation using various drugs or drug combinations supplemented with N_2O (McCann et al. 1996; Houpt et al. 1996; Houpt, 1993; Shapira et al. 1992). All sedative agents were used in doses consistent with the recognised upper limits of therapeutic ranges, and none of these studies reported any significant adverse effects, despite some probability of such.

Rectal Sedation

The rectal route of drug administration has regained interest in anaesthesiology and to some extent in dentistry (Jantzen and Diehl, 1991). In paediatric dental general anaesthesia, it is used to administer analgesic drugs to provide post-operative pain control and as premedication prior to induction (Roelofse et al. 1990a). Advantages of the rectal route include a rapid onset of clinical activity; a decreased incidence and intensity of drug related side effects (Flaitz and Nowak, 1985), the avoidance of an injection, ease of administration, and low cost. Disadvantages of the rectal route include the inconvenience to the operator and patient, variable absorption of some drugs from the large intestine, possible irritation of the intestine, inability to reverse the action of the drug easily, prolonged recovery with some drugs, and the inability to titrate precise individual dosages (Malamed, 1995h). The primary indication for rectal drug administration in both medicine and dentistry are uncooperative patients, whether a child or adult. Signs and symptoms of sedation develop rapidly with many rectal drugs, clinical sedation being evident at 15 to 30 minutes (Roelofse et al. 1990b).

Midazolam has received considerable attention as a rectally administered drug for premedication or sedation (Roelofse et al. 1990b; Roelofse et al. 1990a; van der Bijl et al. 1991; Kupietzky and Houpt, 1993). Various doses of rectal midazolam have been used, ranging from 0.2 to 5.0 mg/kg (Malamed, 1995h). It appears that a rectal dose of approximately 0.35 mg/kg (Roelofse et al. 1990b; van der Bijl et al. 1991) to 0.5 mg/kg (Tolksdorf and Eicj, 1991; Krafft et al. 1993) provides a rapid onset of action, a high level of successful sedation (approximately between 65% and 85%), with minimal intra- or post-operative complications. Roelofse et al. observed that 23% of the 60 children receiving rectal midazolam exhibited disinhibition reactions, particularly those receiving a dose of 0.45 mg/kg. Reactions observed included agitation/excitement, restlessness/irritation, disorientation/confusion, and emotional/crying responses (Roelofse et al. 1990b). Other drugs used for rectal sedation are diazepam (Lowey and Halfpenny, 1993; Flaitz and Nowak,

1985) and ketamine with reported successful procedures in 65% of cases (van der Bijl et al. 1991).

Intranasal Sedation

Intranasal drugs have been employed primarily in paediatrics as a means of avoiding the need for injection or oral drug administration in unwilling patients (Wilton et al. 1988; Saint-Maurice et al. 1990). Clinical trials have demonstrated that absorption and bioavailability of intranasal administered drugs is close to those of IV administration with peak plasma levels of the agent occurring approximately 10 minutes following administration (Rey et al. 1991). Intranasal administration of midazolam has been reported by several authors to be an effective premedication agent before general anaesthesia (Wilton et al. 1988). Fuks and coworkers suggested doses between 0.2 to 0.3mg/kg of midazolam as appropriate premedication for intranasal use in paediatric dentistry (Fuks et al. 1994). Other drugs have also been used via the intranasal route with varied success. A study compared anterograde amnesic effects of midazolam with hydroxyzine in children undergoing dental treatment plus nitrous oxide, using a recall test. This study found that midazolam was more effective in creating amnesia than hydroxyzine (Kupietzky et al. 1996). Administration of drugs via this route to children has disadvantages. These include distress to the child during instillation of the drug, bad taste of the drug (eg midazolam), and possible entry of the drug into the pharynx with coughing and sneezing. This last problem may cause expulsion of the drug with decreased absorption, and therefore unreliable onset and effect of the drug being used (Malamed, 1995i).

Parenteral route

The use of the parenteral route in paediatric dentistry mainly refers to intravenous (IV) and intramuscular sedation. Although IV sedation is highly effective in adults(Malamed, 1995e; Kupietzky and Houpt, 1993), its use in children is limited. One study reported its overall use in children at only 18% (Nathan, 1989). Nonetheless, it has been suggested that used in

combination with RA, IV sedation is a safe and effective sedation modality with minimal side effects (Barr and Wynn, 1992).

There are several potential advantages of the IV route. The onset of action of IV drugs is the most rapid of all of the techniques discussed. On average the arm-brain circulation time is approximately 20 to 25 seconds. Because of this rapid onset, titration of the drug can be done to meet the specific needs of the patient. This is one of the most important safety factors associated with IV sedation. The recovery period for most IV drugs is significantly shorter than that seen for the same drug administered via the oral, rectal or other routes (Malamed, 1995e). Another advantage of the IV route is its ability to provide a degree of amnesia or a lack of recall. Whether amnesia develops or not following an IV procedure depends on several factors. Some drugs are much more likely to provide amnesia than others are. Diazepam, midazolam, lorazepam, and scopolamine are examples of drugs that have a greater degree of amnesia associated with their administration; pethidine and pentobarbital are less likely to provide an amnestic effect. The depth of sedation has an effect on whether or not amnesia develops and on the duration of the amnestic effect (Malamed, 1995e).

One major disadvantage with IV sedation is the need to insert a needle. Children may be particularly difficult to manage via this route because their veins are proportionally smaller, making the venipuncture itself more difficult. Younger children requiring IV sedation will usually pose severe management problems or be physically unable to control themselves (Malamed, 1995e). Parenteral sedation, specifically the intramuscular, subcutaneous, and submucosal routes, has been associated with an increased risk of morbidity and mortality when narcotic drugs are used (Goodson and Moore, 1983). Nevertheless, the parenteral route has been used successfully to provide sedation of young dental patients. Ketamine given intramuscularly has been reported to provide adequate sedation for dental procedures 30-40 minutes long (Okamoto et al. 1992). Also, intravenous administration of midazolam has been used with 73% success (11 out of 15 patients) in children (Schwartz et al. 1992).

However, the variability of responsiveness makes midazolam unreliable when used alone to facilitate dental treatment, and the high dose requirements make close monitoring of children mandatory (Schwartz et al. 1992).

Propofol (Diprivan™) has also been reported as an adequate drug for intravenous sedation in older children and adults. Propofol has a rapid onset of action, rapid clearance, distribution and metabolism, which make it ideal as a sedation agent. Its disadvantages are pain during injection, increased talkativeness, and cost (Rodrigo and Jonsson, 1989; Oei-Lim et al. 1991).

In summary, for those children that cannot be managed with non-pharmacological methods, sedation offers significant advantages. Whilst relative analgesia is undoubtedly the safest and simplest, there remains a group of children for whom it is inappropriate, mainly those of very young age. Other modes of sedation include oral, intranasal, rectal, and intravenous; all have some role to play but are in general somewhat unreliable or unacceptable to the paediatric patient. The result is that GA is still a necessary management tool for the treatment of children.

Aspects of general anaesthesia

History and Development of Anaesthesia

The discovery of anaesthesia was one of the most important advances in medicine not only because it has alleviated the fearful pains of surgery, but also because the whole structure of modern medicine has drawn strength from its success. Surgery itself has been able to accomplish, with its aid, a greater advance in the last century than in all the preceding millennia (Armstrong, 1965). For descriptive purposes, the history of anaesthesia has been divided into three chronological subheadings and the development of day-stay surgery.

The Early Days (1844-1863)

It is reported that on December 10, 1844, in the town of Hartford, Connecticut, Professor Gardner Quincy Colton presented a popular science lecture (Armstrong, 1965; Malamed, 1995b). Professor Colton was an itinerant, travelling around the countryside presenting his show of new scientific and quasi-scientific discoveries to eager audiences. In his show nitrous oxide (N_2O) gas was discussed and demonstrated, and members of the audience were invited to participate on the effects of N_2O. A Hartford dentist, Dr Horace Wells (1815-1848) was present during the show. At the demonstration a store clerk by the name of Samuel Cooley volunteered to receive N_2O. Cooley quickly became intoxicated and while running on the stage, his leg hit the side of a table quite hard yet he continued to carry on unaware of his injury. Wells discussed this occurrence with Professor Colton and arranged for a demonstration of N_2O at Wells's dental office the next day. At the surgery, on December 11, 1844, a reluctant Colton served as the anaesthesiologist as another dentist, Dr John Riggs, extracted a wisdom tooth from Wells. After recovering from the effects of the N_2O, Wells stated that he was unaware of the procedure and that he felt no pain. Wells was taught the process of manufacturing N_2O by Colton, and shortly thereafter began using the gas in his dental practice with great success.

Through his association with William Thomas Green Morton, Wells was able to demonstrate his technique to medical students and faculty at the prestigious Harvard Medical School. Morton, a dentist who became a student and later a partner of Wells in Hartford, eventually left dentistry becoming a medical student at Harvard. Morton was present in the audience on this fateful day. Using a medical student volunteer as a patient, Dr Wells administered N_2O to the patient through a newly developed inhaler. At this time, the bag with the gas was withdrawn much too soon, and therefore, the patient felt some pain while having a tooth extracted. The audience, assuming that the procedure had failed, proceeded to boo and hiss Wells until he was forced to leave the hall, thoroughly humiliated, his demonstration a failure. Within a year or so of his ill-fated demonstration of N_2O a discouraged Wells abandoned the practice of dentistry. On May 30, 1848, Horace Wells, later acknowledged as the founder of anaesthesia, committed suicide while in jail by cutting the femoral artery in his left thigh with a razor (Malamed, 1995b).

The practice of modern anaesthesia is frequently, and rightly, dated from the demonstration of the inhalation of ether vapour, by the dentist Morton (1819-1868). On October 16, 1846 (now called Ether Day), at the Massachusetts General Hospital in Boston USA, he successfully demonstrated its use in front of several prominent medical men. He administered ether to Gilbert Abbott, as the famous surgeon John Collins Warren excised a tumour from the jaw of Mr Abbott. Morton did not discover anaesthesia, nor was he the first person to relieve surgical pain or to use ether. However, he successfully administered the right agent, before the right people, in the right place, at the right moment in history. This ensured that the news of his success spread rapidly around the world and contributed to a revolution in the practice of surgery.

News of the discovery of anaesthesia quickly spread around the world and in a short time ether was being used for surgical operations in every civilised community. Ether was first used in England for a dental extraction on December 19th, 1846. Although it had immediate

acceptance with many there existed a number of people who opposed the introduction of anaesthesia on moral and medical grounds. Opposition was gradually overcome, largely by the influence of Sir James Y. Simpson, Professor of midwifery at Edinburgh (Armstrong, 1965). Simpson introduced ether into the practice of obstetrics for the first time in 1847. He found, however, that the smell of ether hung about his clothes, and he sought for another agent. After experimenting with chloroform, he introduced it in November of the same year. The first of a series of deaths with this agent occurred in January 1848, and the reminder of the century was occupied in a contest between the advocates of the two rival drugs (Malamed, 1995b).

The understanding and general acceptance of anaesthesia was greatly accelerated by the work of John Snow, the first physician after Morton to specialise in anaesthesia. His two books, *On the Inhalation of the Vapor of Ether* (1847) and *Chloroform and Other Anaesthetics* (1858) are considered the great classics of the literature of anaesthesia. It was his administration of chloroform to Queen Victoria at the birth of Prince Leopold in 1853 that finally overcame the opponents of anaesthesia in midwifery.

Anaesthesia Develops (1863-1898)

The end of chloroform was in sight when nitrous oxide was re-introduced by Colton, who ever since he administered the gas to Horace Wells in 1844, had retained a belief in its efficacy. In 1863, he succeeded in opening a clinic in New York "devoted exclusively to extracting teeth with the gas" (Armstrong, 1965). By the year 1881, Colton had administered N_2O to 121,709 patients without a death (Malamed, 1995b).

Although gases had been compressed into cylinders in England as early as 1856, it was not until after 1868 that this method of storage became common and the use of nitrous oxide became extensive. At the same time in Chicago, Dr Edmund W. Andrews, a physician born in Vermont, introduced the inhalation of 20% oxygen to nitrous oxide, a most significant

advance in the history of anaesthesia. In 1872, in England, liquid N_2O became commercially available making its use much more practical and considerably safer. No longer did physicians and dentists have to manufacture their own N_2O with the risk of including impurities in the gas. Elsewhere in the world, in 1881 two developments helped consolidate the use of N_2O. In St. Petersburg, Russia, an obstetrician by the name S. Klikovitsch first used N_2O as an analgesic to relieve the pains of labor. In the same year in Philadelphia, the S.S. White Company begun to supply liquified N_2O to the medical and dental professions. It also introduced a machine that delivered the gas from the cylinder to the patient. By the year 1889 N_2O-O_2 analgesia was being used in dentistry during cavity preparation in Liverpool, England. However significant side effects developed, such as nausea, vomiting and excitement, resulting in the decline of the use of N_2O/O_2 analgesia through the 1890's.

The Twentieth Century to Modern Times

Anaesthesia for general surgery in the late 19th century, relied on the more potent drugs while in dental practice, nitrous oxide persisted as the sole agent. Most administrations of nitrous oxide were by dentists or general medical practitioners rather than anaesthetists in hospitals, and consequently dental anaesthesia developed to some extent in isolation from hospital practice. Some of the problems encountered at the time were the large number of patients who required treatment, the short duration of most dental procedures, the necessity for rapid recovery and economic factors, which demanded that cost was minimal. Only the brief duration of the procedure and the comparative youth of the patients allowed this technique to persist, but popularity was the stimulus for the development of specific equipment to meet the needs of the practitioner. The nasal mask was introduced in 1899 and allowed more extended surgery. With the availability of cylinders of the gas, equipment of the 'on demand' variety was devised (1910) and has persisted in dentistry to the present day (Braid, 1989).

Pierre-Cyprien Oré of Bordeaux, France, was the first person to administer a drug intravenously (chloral hydrate) to achieve general anaesthesia in 1872. The successful use of this route in humans was made in 1903, when Emil Fisher and J. von Mering synthetised the first barbiturate, barbitone (Driscoll, 1978). This discovery gave Fisher the Nobel Prize in Medicine in 1903. In 1935 John S. Lundy at the Mayo Clinic in Rochester, Minnesota, introduced sodium thiopental. This short duration IV anaesthetic quickly became the most popular drug in the United States for the induction of general anaesthesia (Malamed, 1995d). In 1945 Niels Bjorn Jorgensen became probably the first person to use the IV route to provide what Jorgensen himself termed IV premedication (Jorgensen and Leffingwell, 1953).

Development of Day-stay Anaesthesia

The series of events that gave impetus to the growth of day-stay (outpatient) surgery started with the beginning of the 20th century. Nicoll first documented the practice of day-stay surgery when he presented to the British Medical Association the results of 8988 operations on outpatients performed at the Glasgow Royal Hospital for Sick Children between the years 1899 and 1909 (Nicoll, 1909). Previously, many children were admitted to hospital for periods of days or weeks, for relatively simple surgical procedures. Day-stay surgery had several advantages compared to inpatient surgery: it reduced the emotional stress of the child, by not separating him/her from the family environment, it decreased the possibility of hospital acquired infections, and it reduced the cost of treatment (Steward, 1975). Since these beginnings early in the century, other events took place which slowly helped the growth of day-stay surgery. From 1916, numerous centers and facilities were opened as well as several day-stay surgical programmes by different universities across the USA (Henderson, 1991).

Despite its apparent success, it was not until the late 1960s that the technique gained wider acceptance. Children that on clinical grounds were suitable for day surgery, accounted for between one-quarter and one-third of the surgical work-load of one particular paediatric hospital, yet many surgeons still preferred to admit these patients the day before of the operation and discharged them the following morning. This was mainly due to administrative difficulties associated with day surgery (Armitage et al. 1975). During the late 1960s and 1970s, day-stay became more widely used and was reported to make for a more efficient use of the operating time and a reduction in waiting lists (McDonald, 1983; Rainey and Ruckley, 1979). The use of day-stay surgery has continued to expand since its gain in popularity in the 1970s. In the USA alone, 66% of all surgery was performed as day-stay surgery in 1994 (Korttila, 1995).

In dentistry, general anaesthesia has been traditionally in the form of a short outpatient procedure for simple extractions, often done in dental surgeries and taking no more than a few minutes to complete (Armstrong, 1965; Smallridge et al. 1990). The introduction of general anaesthesia in specialised day-care facilities, whilst avoiding hospital admission, provides a longer operating time, allowing conservative treatment or minor oral surgery to be carried out. An important advantage of this method in children is that in the majority of cases, all treatment could be provided at a single operating visit, a factor that may well contribute to the acceptability to patients and parents (Holt et al. 1991). Dental treatment under general anaesthesia has shown to be efficacious and associated with low failure rates in the restorative work carried out (O'Sullivan and Curzon, 1991; Mitchell et al. 1985).

For these reasons, day-care facilities proved to be of particular value in children who are physically, mentally or emotionally handicapped and for those with extensive treatment needs (Rule et al. 1967). More recent studies from Belgium and the United States have confirmed this finding (Enger and Mourino, 1985; Vermeulen et al. 1991; Boulanger, 1990; Bohaty and Spencer, 1992).

Safety of General Anaesthesia

Dental general anaesthesia is still a controversial topic, even though about 2 million general anaesthetics were recorded annually in the United Kingdom between 1950-1970 (Muir et al. 1976). Up until the early 1960s, it was common practice for many dentists to act as both, operator and anaesthetist. Following an apparent increase in the number of deaths resulting from general anaesthetics administered for dental treatment, the Council of the British Dental Association (BDA) reviewed the policy in relation to the operator administered general anaesthetic (Working Party Report, 1975). At the time, the number of GAs administered annually in dental practices was not known with any accuracy. During 1973 in England and Wales 1.2 million general anaesthetics were given under the National Health Service (N.H.S.). In addition, an unknown number of general anaesthetics were given in private practice. Therefore, the number of GAs administered privately may have well exceeded the number of anaesthetics administered by the N.H.S. (Working Party Report, 1975).

The BDA adopted the policy that, in the interests of the patient and of the practitioner, it was desirable that a dental or medical practitioner other than the operator should administer a general anaesthetic. As a result, the number of operator administered GAs diminished steadily from 26% (single operator/anaesthetist) in 1963, to 17% in 1968 and 11% in 1973 (Working Party Report, 1975).

Morbidity and Mortality

Morbidity and mortality statistics are used to determine the safety of sedation and general anaesthesia in the dental/medical set-up. Morbidity is defined as the ratio of sick to well in the community, whereas mortality is the relative frequency of death or death rate in a community, and it is expressed as a ratio of deaths to the total population (Delbridge and Bernard, 1995). Unfortunately, most of the surveys and studies of morbidity and mortality

related to dental anaesthesia lack specific details, which make impossible to extract information that may be helpful in reducing dental surgery mishaps (Campbell, 1986).

Day surgery has a remarkable record of safety. An American study reviewed over 45,000 consecutive day-stay procedures and concluded that the risk of major morbidity and mortality does not differ from that in similar populations undergoing overnight admission surgery (Warner et al. 1993).

Mortality of General Anaesthesia

Mortality rates are commonly used as indices of safety when referring to GA. Several studies report on the incidence of mortality related to the use of general dental anaesthesia and these are summarised in Table 1.2 (Goldman, 1960; Bishop and Potts, 1961; Bourne, 1970; Coplans and Curson, 1973; Coplans and Curson, 1993; Coplans and Curson, 1982; Krippaehne and Montgomery, 1992; Lytle and Yoon, 1980; Nkansah et al. 1997; Tomlin, 1974). In comparison, Table 1.3 shows some studies on the mortality of medically related GAs (Alexander et al. 1965; Holland, 1987; Tiret et al. 1988; Zeitlin, 1989; Warden and Horan, 1996; Working Party Report of ANZCA, 1998). The purpose of these tables is to show the relative mortality rates since the 1950s, and they are not meant to be exhaustive in nature. The often quoted mortality rate favourably comparing outpatient dental case mortality (1/137 000 to 1/860 000 quoted) with hospital anaesthetic mortality (1/10 000 to 1/19 000) is due to the fact that specific criteria for determining these ratios differs widely among authors (Jastak, 1992).

Table 1.2: Studies reviewing the mortality rate of dental general anaesthesia

Author(s) & year	*Country*	*Period of study*	*No. deaths*	*Mortality rate*	*Deaths related to*	*Comments*
Goldman (1960)	UK	1952-58	100	1:219,000 GAs	Dental GAs	Halothane used successfully
Bishop & Potts (1961)	UK (London)	1939-59	1	1:103,000 GAs	Dental GAs (Guy's Hospital)	33% of GAs given to children under 12 years
Bourne (1970)	UK	1966-70	16	-	-	15 deaths due to GA; 1 death due to LA
Coplans & Curson (1973)	UK	1968-71		1:124,000	Dental exos	
Tomlin (1974)	UK (England & Wales)	1963-68	48	1:300,000 1:15,000	Dental (private) Dental (hospital)	17 deaths occurred in hospital & 29 in private practice
Lytle & Yoon (1980)	USA	1973-77	-	1:860 000 GAs between 1968-77	Dental (private)	Survey of a USA Society of Oral & Maxillofacial surgeons
Coplans & Curson (1982)	UK	1970-79	120	1:10,000	Dental (hospital)	100 deaths due to GA, 10 to LA.
Krippaehne & Montgomery (1992)	USA	1977-92	35		Dental (private)	Lack of monitoring a key factor in mortality/morbidity
Coplans & Curson (1993)	UK	1980-89	71		Dentistry or dental GAs deaths	4 deaths involving op/anaesthetist compared to 13 between 1970-79
Nkansah (1997)	Canada	1973-95	4	1.4:1 million	Dental GAs	Greater safety of day-stay proc.

Author(s) & year	*Country*	*Period of study*	*No. deaths*	*Mortality rate*	*Deaths related to*	*Comments*
Alexander et al (1965)	USA	1953-64	17	1.03:10 000 proced.	Tonsillectomy (in hospital)	Only one death in the last four years of the study
Holland (1987)	Australia	1960-87	5262	1960 1.45:100 000 1984 0.44:100 000	Deaths in NSW	Approx. 5 times safer to have GA in 1987 as to 1960
Tiret (1988)	France	1978-82	1	1:40 240 GAs	440 institutions; GAs done in children only	Risk of complications significantly higher in infants than in children
Zeitlin (1989)	USA	1955-64 1977-84	15 31	2.16:10 000 GAs 0.16:10 000 GAs	Hospital figures compared to litigation claims	This suggests a 13 fold decrease in mortality between periods
Warden (1996)	Australia	1984-1990	1503	1:20 000 GAs 0.44: 100 000 pop.	Deaths before full recovery from GA	172 deaths attributed to anaesthesia of which 161 were due to errors
Horan (1998)	Australia	1991-93	116	6.6: 1 000 000 population	Data compiled from all States	Only two child deaths during study

Table 1.3: Studies reviewing the mortality rate of medical general anaesthesia.

In comparison to general anaesthesia, local anaesthesia is undoubtedly safer with a mortality rate of almost nil. A review of the complications of local anaesthesia did not record one death (Jorgensen and Hayden, 1965), but another study recorded three deaths between 1963-68 (Tomlin, 1974). A more recent study by Coplans & Curson found three deaths related to local anaesthesia (prilocaine with felypressin), but in all three cases death appeared to be secondary to another condition, e. g. severe cardiovascular pathology (Coplans and Curson, 1993).

A study of deaths associated with dentistry and dental disease in England and Wales showed that there were fewer deaths associated with dentistry between 1980-89 as compared to 1970-79. Whilst most of the deaths were still associated with general anaesthesia, the total number decreased from 120 to 71, as did the percentage of deaths in which general anaesthesia was thought to play a significant part (Coplans and Curson, 1993).

In Australia, a recent report found 116 anaesthesia-attributable deaths during 1991-93. When considering that 7.8 million anaesthetics were administered, the national incidence of death attributable to anaesthesia was around one per 68,000 anaesthetics. There were few deaths in young children attributed to anaesthesia, which may suggest that the standard of paediatric anaesthesia in this country is high (Working Party Report of ANZCA, 1998).

Morbidity of General Anaesthesia

Morbidity is considered a more useful parameter than mortality when discussing complications associated with general anaesthesia, as it describes to some extent the nature of the problems encountered. Although life-threatening complications after day-stay anaesthesia are rare, discomfort that prolongs or complicates recovery is common. Follow up studies with reference to post-anaesthetic and post-operative sequelae have reported a high number of patients with post-operative symptoms (Yee et al. 1985; Smith and Young, 1976;

Ogg, 1972; Ogg et al. 1983). One study found that 78% of patients went home with symptoms such as drowsiness (46%), dizziness (40%), and/or headache (58%) (Smith and Young, 1976). Another found that patients complained about symptoms in 61% of cases (Ogg, 1972). In contrast, an Australian study found minimal morbidity following oral surgery procedures (mostly surgical removal of third molars) and a high degree of patient satisfaction (Hempenstall and de Plater, 1991). Furthermore, a review comparing morbidity of general anaesthesia with local anaesthesia found little difference for outpatient dental procedures (Muir et al. 1976), although another study did show considerably fewer post-operative side effects with local anaesthesia alone (Ogg et al. 1983).

In paediatric anaesthesia, the most commonly reported complications before discharge are sore throat, headache, muscle pains, nausea and vomiting, and postoperative pain (Hannallah and Epstein, 1994). In order to describe these methodically, morbidity of paediatric outpatient anaesthesia will be divided into:

- Airway complications
- Cardiac complications
- Post-operative nausea and vomiting
- Post-operative admission following complications
- Complications related to dental treatment

Airway complications

The main complications arising from the airway are laryngospasm and stridor.

Laryngospasm: This is usually a transient event but can be potentially life threatening. During laryngospasm, either the true vocal cords or the true and false cords become opposed in the midline and close the glottis. Thus, laryngospasm is an involuntary closure of the glottis by the intrinsic laryngeal muscles (Brett et al. 1994). A study reported on the incidence of laryngospasm during 156,064 anaesthetics delivered to 136,929 patients. The overall incidence of laryngospasm in children was relatively high compared to adults.

Children between the ages of 0 to 9 years had an incidence of 17.4 events/1000 patients compared with 8.7/1000 for the whole population. Asthma and respiratory infection were associated with an increased incidence of laryngospasm in children (Olsson and Hallen, 1984).

Stridor: Stridor is defined as noisy breathing secondary to turbulent flow through the narrowed lumen of an airway (Brett et al. 1994). Thus, it is a symptom of many different problems that produce a narrowed, partially obstructed airway. In general, inspiratory stridor is caused by upper airway obstruction, secondary to lesions such as laryngeal anomalies, adenotonsillar hypertrophy, midfacial hypoplasia, and croup. Expiratory stridor is most commonly associated with lower airway obstruction from lesions such as cysts, hemangiomas, vascular rings, and foreign bodies. In children, a tube that allows a slight leak of gas around is preferred during positive pressure ventilation, as this decreases the incidence and severity of post-intubation stridor or croup (Brett et al. 1994; Hannallah and Epstein, 1994). Despite proper selection of a tube, children that undergo long anaesthetic procedures can still experience post-intubation croup. This is possibly secondary to surgical manipulation of the jaw against the endotracheal tube during the surgery. Fortunately, croup that is severe enough to cause respiratory distress almost always occurs during the recovery phase rather than after discharge. Therefore many centres do not allow children to be discharged within three hours of tracheal extubation (Hannallah and Epstein, 1994).

Cardiac complications

The most common cardiac complications in children associated with day-stay dental general anaesthesia are cardiac dysrhythmias and bacterial endocarditis. A dysrhythmia is any deviation from the normal sinus rhythm of the heart. A high incidence of cardiac dysrhythmias during GA for minor oral surgery has been reported in the past (Fisch et al. 1969; Thurlow, 1972; Ryder and Townsend, 1974). Dysrhythmia was reported as the most common intraoperative complication occurring in 112,721 patients at a major teaching

hospital (Cohen et al. 1986). These dysrhythmias appear to be due to the beta effects of catecholamines acting on a myocardium sensitised by halothane. Unpremedicated children undergoing dental extractions with a halothane/nitrous oxide/oxygen anaesthetic have also been noted to experience cardiac dysrhythmias (Thurlow, 1972; Plowman et al. 1974; Haden, 1985). These have been attributed to light anaesthesia, elevated endogenous catecholamines (especially likely in the highly nervous patient), lack of pre-operative anticholinergic medications, and trigeminal stimulation(Vermeulen et al. 1991; Plowman et al. 1974; Thurlow, 1972; Miller et al. 1970).

The interruption of afferent surgical stimuli by infiltration with local anaesthetic appears to be effective in significantly reducing the incidence of cardiac dysrhythmias. This confirms that surgical stimulation is an important aetiological factor in producing dysrhythmias during general anaesthesia with nitrous oxide/oxygen and halothane, for oral surgery (Plowman et al. 1974). Other precipitating factors for dysrhythmias include carbon dioxide retention (hypercarbia), tracheal intubation (especially when the patient is in a light plane of anaesthesia), anoxia or severe hypoxia, and the duration of the GA procedure. Occasionally, disturbances of cardiac function may occur with the introduction of throat packs, or they may be associated with the placement of props or gags (Braid, 1989).

The need for antibiotic prophylaxis in children with heart disease undergoing dental treatment is well recognised (Berry, Jr. et al. 1973b; Berry, Jr. et al. 1973a). The incidence of bacteremia in children has been found to be higher when nasotracheal intubation is used. A study comparing ways of intubation found that 16% of children had bacteremia with nasotracheal intubation, whereas no bacteria could be detected in those with orotracheal intubation (Berry, Jr. et al. 1973a). Bacterial invasion into the blood circulation occurs due to traumatic nasotracheal intubation and is more likely to occur in patients with poor oral hygiene and extensive dental procedures (Morrow et al. 1986). Because of this higher incidence of bacteraemia associated with nasal versus oral intubation as well as the high

incidence of bacteraemia following dental restoration and extraction, it is imperative that children with congenital heart disease be given prophylactic antibiotics to prevent subacute endocarditis. Appendix 2 provides guidelines for prophylaxis of bacterial endocarditis followed at the Westmead Dental Clinical School (Cameron and Widmer, 1997).

Post-operative nausea and vomiting

Nausea and vomiting are the most frequently reported postoperative complications. The cause and frequency of postoperative vomiting are complex because there are many associated variables (Oh and Davis, 1990). The aetiology and incidence of nausea and vomiting associated with general anaesthesia have been reviewed in the literature (Palazzo and Strunin, 1984). These authors stated that, in the absence of antiemetics, the incidence of emetic difficulties is approximately 30%. Factors implicated included gender, fasting, elevated catecholamines levels, opiates, excessive ventilation via a face mask, pain, hypotension, and rough handling of the patient. The incidence of nausea immediately post-operatively was 22% with a 6% incidence of actual vomiting (Palazzo and Strunin, 1984). These figures compare favourably with the findings of others where an incidence of nausea approaching 50% with 22% vomiting was not uncommon (Yee et al. 1985; Smith and Young, 1976; Ogg et al. 1983).

The incidence of nausea and vomiting varies also with the type and length of the surgery performed. Intractable vomiting is commonly associated with tonsillectomy and adenoidectomy (Ahlgren et al. 1971) and with strabismus surgery (Abramowitz et al. 1983). Vomiting is twice as common after operations that last more than 20 minutes compared to those that take less than 20 minutes. The frequency of vomiting in intubated, unpremedicated children who receive nitrous oxide/halothane anaesthesia for strabismus can be as high as 80% (Abramowitz et al. 1983). Other studies have shown lower incidence of vomiting in patients under 3 years of age and a high incidence in premedicated patients (Rowley and Brown, 1982).

The ability to drink clear liquids without vomiting after anaesthesia and surgery is a commonly used criteria for discharge of paediatric surgery patients. A study of 989 child patients undergoing day-stay GA found that 14% of the children that were allowed to drink during the recovery period vomited (group called 'elective' drinkers), as compared with 23% of those children that were required to drink prior to discharge ('mandatory' drinker group). This difference was statistically significant as was the more prolonged stay in the recovery unit by the group of mandatory drinkers. This study concluded that it was unnecessary to make drinking a prerequisite for discharging paediatric patients after day surgery (Schreiner et al. 1992).

Post-operative admission following complications

Unexpected hospital admission following outpatient surgery has become an important measure of outcome in day-stay surgical care. Moreover, unexpected admission to the hospital reflects unanticipated patient morbidity and disrupts the smooth management of day-stay surgical practices (Gold et al. 1989). One per cent of all patients require hospital admission following day-stay surgery (Steward, 1975; Patel and Hannallah, 1988; Gold et al. 1989). One survey of 9616 adult patients who underwent day-stay surgery found that the likelihood of unanticipated admission was related to the type of anaesthesia and surgical procedure rather than to any patient characteristics (Gold et al. 1989).

Postoperative admission rates between 0.9% and 2.6% following dental procedures have been quoted (Vickers and Goss, 1983; Yee and Davis, 1984). This last study found that these admissions were not the result of any single anaesthetic or surgical misadventures, but due to the procedure being more complicated or traumatic than expected (Vickers and Goss, 1983). In addition to severe vomiting, the most common reasons for unplanned admission in paediatric outpatient anaesthesia are postoperative croup, fever bleeding, sleepiness, family requests, and surgical complications (Oh and Davis, 1990; Hannallah and Epstein, 1994).

Complications related to dental treatment

The main complications arising from dental procedures under general anaesthesia include airway maintenance related problems (both with and without the presence of an endotracheal tube), cardiac dysrhythmias associated with dental procedures (already discussed), postoperative pain, and subcutaneous emphysema.

Airway maintenance: The benefits of tracheal intubation via the nasal route include better surgical access to the oral cavity, easier fixation and greater patient comfort if intubation is to continue into the postoperative period. One study reported on the pathological changes associated with short-term nasal intubation in 100 patients undergoing dental extractions under general anaesthesia. Minor bruising was common (reported incidence of 54%) and most frequently involved mucosa overlying the inferior turbinate and adjacent septum. There was no relationship between the number of attempts at intubation and subsequent damage. Overall, results showed that there was no significant nasal morbidity, and pre-operative assessment failed to identify those in whom nasal intubation proved difficult or impossible (O'Connell et al. 1996). Nasal intubation can be traumatic when nares are congested or constricted, and bleeding may be excessive. Adenoidal tearing and bleeding may occur, with the additional danger of carrying debris and microorganisms into the trachea and lungs (Berry, Jr. et al. 1973a). If the endotracheal tube is forced against the nostril, a pressure spot followed by a disfiguring scar may result. Although this complication is of little danger, it has the potential to upset the patient (Smith, 1990). Placement of a throat pack may stimulate cardiac arrhythmias, constrict the endotracheal tube, or lead to postoperative pharyngeal irritation, hoarseness or both (Smith, 1990), however this is rarely of major relevance. Another complication of endotracheal intubation is the likelihood of damage to the teeth or lips by the laryngoscope while securing an airway for adequate ventilation of the patient. Such damage formed the basis for one third of all confirmed or potential anaesthetic claims notified to one medical protection society in the UK (Chadwick and Lindsay, 1996;

Chadwick and Lindsay, 1998). Similar studies restricted to child dental anaesthesia have not been reported.

Postoperative pain: Little is known about postoperative pain in children following extraction of teeth under GA. Analgesic requirements of children following dental surgery are highly variable and postoperative analgesics are administered to children less frequently than to adults (Abu-Saad, 1984), probably due in part, to the difficulty in evaluating pain in children (Moore et al. 1985). There is evidence from studies of adults following the removal of impacted third molars, that postoperative pain is highest on the day of surgery, but the precise pattern of pain and the timing of maximum pain intensity varies (Chapman, 1988; Fisher et al. 1988). However, whether the severity and timing of any pain after less invasive procedures in children follows the same pattern is unknown. One prospective study investigated factors influencing postoperative pain in children undergoing extractions under general anaesthesia. The most significant factor appeared to be the relationship of the accompanying adult to the child: children attending with their mothers were more likely to complain of postoperative pain. Pain was reported by 57.5% of children immediately after treatment, indicating that the need for postoperative analgesia may be helpful and should be given immediately after the procedure (Fung et al. 1993).

Subcutaneous emphysema: Air driven (approximately 30 psi of pressure) ultra high speed dental handpieces and the use of air syringes (20-25 psi.) can cause subcutaneous emphysema in the facial and cervical areas that may extend into the mediastinum and result in pneumothorax, pneumomediastinum, pneumopericardium, and intravascular air embolism (Milne et al. 1982; Rosenberg et al. 1979). Reports of subcutaneous emphysema in children undergoing general dental anaesthesia have occurred in long restorative sessions, ranging from 1.5 to 4 hours (Rosenberg et al. 1979; Levy, 1981). However this complication would appear to be rare.

Several other problems may arise during the delivery of dental treatment to children under general anaesthesia.

- Dislocation of the temporomandibular joint occurs not infrequently in children if the mouth is opened widely. It predisposes to airway obstruction by altering the position of the tongue and its occurrence should alert the anaesthetist to the possibility of obstruction. Reduction of the dislocation is usually readily obtained and long term sequelae is rare (Braid, 1989).
- Particular care must be taken with the insertion of mouth props as deciduous teeth can be easily dislodged (Braid, 1989).
- Cotton rolls placed between cheeks and teeth may obstruct the salivary ducts and cause painful swelling of the parotid glands (Smith, 1990).

Anaesthesia: drugs and monitoring

Despite the current popularity of outpatient surgery, there is still no agreement among anaesthetists as to what constitutes the best way to ensure smooth induction of, and rapid and comfortable recovery from anaesthesia without compromising safety. A particular agent or technique should be chosen and tailored to fit the needs of the individual child, not used merely because it is routine in a particular institution or is the only method with which the anaesthetist is comfortable (Hannallah and Epstein, 1994). The use of general anaesthesia in paediatric dentistry involves either inhalational or intravenous induction of anaesthesia. A short description of the drugs most commonly used in children is given below.

Inhalational Induction of Anaesthesia

Inhalational induction refers to the use of gaseous agents to bring about the state of anaesthesia. A successful inhalational induction of anaesthesia requires the child's cooperation and acceptance, especially in the outpatient environment where premedication is

not always used. There are several inhalational anaesthetics available for use in dental anaesthesia, and the four most commonly used agents will be discussed in brief.

Nitrous Oxide

Nitrous oxide (NO_2) is a non-irritating, sweet-smelling, colourless gas. It is the only non-organic compound other than CO_2 that has any CNS depressant properties and is the only inorganic gas used to produce anaesthesia in humans. NO_2 is relatively insoluble (coefficient of 0.47 at 37° C) in the blood and is carried in physical solution only, not combining with any blood elements. Nitrous oxide has the great advantage of being practically odourless, which makes it suitable for starting inhalational induction in the paediatric patient. Unfortunately, this gas has limited potency (minimum alveolar concentration of 105%), and for that reason it is usually supplemented with potent inhalational or IV anaesthetics (Hannallah and Epstein, 1994).

Halothane

Halothane is a halogenated hydrocarbon with a blood/gas partition coefficient of 2.3 and has a characteristic 'sweet' odour. It is nonflammable which allowed the use of electrocautery by the surgeon and the introduction of extensive electronic monitoring by the anaesthetist. It is a potent agent capable of inducing any depth of anaesthesia required. Due to its poor analgesic properties, halothane is most often used with nitrous oxide or a narcotic analgesic (Malamed, 1995a). It is widely used in children due to its low cost, good patient acceptance, ease of administration, and lack of irritant effects on the airways (Olsson, 1995). For the outpatient it offers the advantage of a rapid, smooth induction, either by direct inhalation (accompanied by nitrous oxide) or after induction with an IV agent. Initial use of high inspired concentrations (up to 3%) speeds the induction of anaesthesia; however, this is quickly reduced to the usual maintenance range of 0.5 to 2% (Hannallah and Epstein, 1994).

Disadvantages of halothane include myocardial depression, cardiac dysrhythmias, sensitisation of the myocardium to the actions of catecholamines, and hepatotoxicity among others (Malamed, 1995a). Recovery after brief halothane anaesthesia is usually rapid and uneventful. Nausea and vomiting are not common. However, recovery time is longer with prolonged administration. Although there is a tendency to avoid repeated use of halothane in adult outpatient anaesthesia for fear of sensitising the liver and possibly inducing hepatic necrosis with future exposure, it is generally believed that this is rarely a problem in the preadolescent child (Smith, 1980).

Isoflurane

Isoflurane is a chemical isomer of enflurane (Ethrane). Isoflurane has a pleasant odour, it is non-irritating (produces no secretions), it is a brochodilator, it provides excellent muscle relaxation, it keeps the cardiac rhythm stable, it is compatible with adrenaline and it is non-flammable (Malamed, 1995a). It has a low blood/gas solubility coefficient, which should make induction of anaesthesia and postoperative recovery more rapid than with halothane. Isoflurane, like enflurane, tends to provoke more excitement, breath holding, coughing and laryngospasm during induction than halothane (Hannallah and Epstein, 1994).

Sevoflurane

Sevoflurane, a fluorinated ether with low blood solubility (0.63) is the newest inhalational anaesthetic available for both induction and maintenance of anaesthesia in paediatric outpatients. Its pleasant, non-irritating odour and lack of pungency allow a rapid increase in inspired concentration during induction and therefore a rapid onset. Recovery from short anaesthetics after sevoflurane appears to be fast and to be associated with minimal side effects (Hannallah and Epstein, 1994). Sevoflurane has negligible airway irritant effects, which facilitates a "smooth" induction, even in comparison with halothane in paediatric patients, and makes it particularly suitable for rapid induction of anaesthesia in adults and children. Emergence, orientation and postoperative cognitive and psychomotor function

recovery of paediatric outpatients is significantly more rapid from sevoflurane than from halothane anaesthesia (Patel and Goa, 1996; Kataria et al. 1996). Sevoflurane is well tolerated by adult and paediatric patients during induction of anaesthesia, with a low incidence of mild airway complications (breath-holding, coughing, excitement and laryngospasm). During rapid induction, it is better tolerated than isoflurane or halothane (Patel and Goa, 1996).

Intravenous induction of Anaesthesia

Intravenous induction (IV) of anaesthesia is the method of choice in older children, as it ensures a rapid, pleasant induction with minimal struggling and no unpleasant memories of a suffocating mask or a smelly gas. The real limitation to the more frequent use of IV induction in children is the anaesthetist's attitude and experience. It is likely that, with the availability of short acting IV agents such as propofol, the use of topical anaesthetics (e. g. EMLA) to minimise discomfort during venipuncture (Soliman et al. 1988), and the increased concern about the level of wasted inhalational agents, the use of IV anaesthesia may become more common in the future. At present, the two most commonly used drugs for intravenous induction are thiopentone followed by halothane in 30% oxygen and 70% nitrous oxide, and propofol followed by maintenance boluses of the same drug with 30% oxygen and 70% nitrous oxide (Puttick and Rosen, 1988).

Thiopentone

Thiopentone is a short-acting barbiturate with potent anaesthetic properties. It provides poor analgesia but the induction period is smooth and very quick. Thiopentone as a 2.5% solution is a common induction agent for adult outpatient anaesthesia. In a dose of 4 to 5 mg/kg it is equally suitable for children (Hannallah and Epstein, 1994). Toxic reactions and side effects include respiratory depression, apnea (cessation of breathing >20 seconds), coughing and laryngospasm. Brochospasm may occasionally develop in asthmatic patients. In a standard concentration of 2.5%, thiopentone (due to the high alkalinity of the solution and the

chemical nature of the drug) is irritant to tissue, and intra-arterial injection or extravasation may result in tissue necrosis.

A study comparing the recovery time after thiopentone induction and inhalational induction in children found that half an hour after surgery there was no difference in the recovery score between the two groups. However, children induced with a barbiturate agent (e. g. thiopentone or methohexital) tended to be sleepier and required more airway support for the first 15 minutes of the recovery period. Also, there was no difference in the eventual return to a "bright and alert" status and normal appetite at home after discharge from hospital (Steward, 1975).

Propofol

Propofol (2,6 diisopropylphenol) is a short acting hypnotic considered the most suitable intravenous drug available for the anaesthetic management of outpatients. Propofol is presented as an emulsion in soybean oil (Diprivan™), a vehicle that supports bacterial growth, therefore extreme caution with asepsis is required. It offers many advantages, including rapid onset and very prompt and pleasant recovery, with minimal nausea and vomiting (Hannallah and Epstein, 1994). The induction dose in healthy children is reported to be around 3 mg/kg. Unfortunately, propofol administration is associated with a high incidence of pain and burning sensation when small hand veins are used for injection. The incidence of pain on injection has been reported to be as high as 31% when the veins on the dorsum of the hand are used, as compared to 8% when the antecubital veins are used (Valtonen et al. 1988; Hannallah et al. 1991).

Monitoring during general anaesthesia

Monitoring of appropriate physiological functions of a patient, during both sedative procedures and general anaesthesia, allows the early detection of adverse side effects that

may be produced by drugs or by clinical actions. The purpose of monitoring is to detect potential problems. It is not a substitute for close clinical observation by the anaesthetist, who must maintain constant contact with the patient and continuously evaluate and integrate all incoming information (Gregory, 1994a). While human error is responsible for about 86% of preventable anaesthetic mishaps, equipment failure has accounted for approximately 14% of the morbidity and mortality of general anaesthesia (Cooper, 1978). Proper assessment of the paediatric patient undergoing anaesthesia involves cardiovascular, respiratory, temperature and other type of monitoring (Gregory, 1994a):

- *Cardiovascular monitoring:* Monitoring of the pulse, heart rate and rhythm is recommended for all patients as a part of the routine pre-operative evaluation. Monitoring at regular intervals is desirable in all sedation techniques, usually at intervals of 15 or 5 minutes depending on the amount of CNS depression. In general anaesthesia, continuous monitoring is mandatory. The heart rate and rhythm may be measured manually or by electronic methods. At present, pulse monitors, such as the pulse oximeter (see later) allow continuous monitoring of the heart rate, and they are preferred over other devices (Malamed, 1995f). The electrocardiogram (ECG) is also an important adjunct to cardiac monitoring in the operating room, as infants and children frequently become bradycardic during anaesthesia (Gregory, 1994a). General anaesthetics decrease the blood pressure of infants and children more than that of adults. Children also tend to loose blood relatively more rapidly than adults. Consequently, blood pressure should be monitored in all patients. For this measurement to be accurate in children, the blood pressure cuff must be an appropriate size for the patient (Gregory, 1994a).

- *Respiratory monitoring:* Of at least equal if not greater importance than monitoring of cardiovascular function during general anaesthesia is monitoring of respiration. Because the drugs used to provide general anaesthesia are CNS and respiratory depressants, changes in breathing will usually be observed well before the cardiovascular changes are

noted (Malamed, 1995f). Clinically unsuspected hypoxia occurs considerably more frequently than was thought prior to introduction to oximetry (Cote et al. 1991; McKay and Noble, 1988). A study of 402 paediatric anaesthetics concluded that the pulse oximeter is far superior to either the capnograph (see later) or clinical judgement in providing the earliest warning of desaturation events (Cote et al. 1991). The use of pulse oximetry has become a standard of care during general anaesthesia, whether for inpatients or outpatients (Malamed, 1995f; Rosenberg and Campbell, 1991). Pulse oximeters enable the anaesthetist to monitor oxygenation continuously and they accurately reflect the saturation of oxygen (SaO_2) of infants and children of all ages when the SaO_2 is above 70%. It is much less accurate in hypoxic infants (Costarino et al. 1987). Monitoring end-tidal gases gives early warning of changes in oxygen, carbon dioxide, and anaesthetic concentrations (Gregory, 1994a). The capnography device monitors the levels of inspired and end tidal CO_2, providing visual displays as percentage or millimetres of mercury. Response is virtually instantaneous, assessing every breath taken by the patient. Currently, the most ideal monitoring system for ventilation appears to be the combination of pulse oximeter and capnography (Aka and Jedrychowski, 1995).

- *Temperature:* It is important to determine the temperature prior to the start of anaesthesia, as fever increases the workload of the cardiovascular and respiratory systems. The heart rate increases with increased temperature as does the rate of respiration, and the patient's ability to tolerate stress decreases. The importance of monitoring temperature during general anaesthesia is based on the need to prevent severe hypothermia, and to monitor for the possible development of malignant hyperthermia (Malamed, 1995f).

- *Other:* Monitoring parameters such as metabolic function, urine output, blood loss, or intracranial pressure are also required in certain circumstances. However, the need to use

them during a typical outpatient dental procedure on an ASA I or II patient is questionable (Malamed, 1995f). Such techniques are not relevant to this review and can be found in the literature (Gregory, 1994a).

Monitoring and Dentistry

Physiological monitoring of patients is essential in assuring the success and safety of sedation. However appropriate monitoring practices in dentistry are not widespread. A report comparing 43 cases of morbidity and mortality from pharmacosedation in dentistry found that complications occurred in young healthy patients, in whom multiple drug agents were used with limited monitoring and resuscitative efforts. Heart rate was *not* monitored in 68%, respiration in 77%, blood pressure in 77%, tissue oxygen saturation in 92%, and heart rhythm in 97% (Krippaehne and Montgomery, 1992). The authors concluded, and others agreed, that lack of adequate monitoring is a key factor in the majority of morbid and mortal events (Krippaehne and Montgomery, 1992; Jastak, 1992). Furthermore, a survey of monitoring practices of 261 American paediatric dentists revealed that the most frequently used methods were clinical observation, pulse oximetry, and precordial stethoscope. However, most paediatric dentists (87%) who used sedation did not involve a separate operator to deliver sedation/anaesthesia (Aka and Jedrychowski, 1995).

Pulse oximetry for monitoring children in dentistry has been found to detect oxygen desaturation faster than conventional methods such as clinical observation. The results of a study showed that children sedated with 50 mg/kg chloral hydrate and 25 mg hydroxyzine in conjunction with 40 percent nitrous oxide and 60 percent oxygen may have respiratory difficulties which are not detected by the traditional monitoring of blood pressure, pulse, respiratory rate and skin colour. The use of a pulse oximeter that noninvasively measures oxygen saturation of hemoglobin (SaO2) allowed earlier detection of respiratory distress than the other methods mentioned (Whitehead et al. 1988).

Special considerations of paediatric general anaesthesia

Day-stay surgery has improved tremendously in the last twenty years, and paediatric patients are now provided with care that is similar to that available to in-patients, without an increased risk of morbidity and mortality. Improved anaesthetic drugs and techniques, better monitoring equipment, and an increased awareness and understanding of the psychological and physiological differences between paediatric and adult patients have helped to maintain the safety statistics (Campbell et al. 1982).

Paediatric anaesthesia as a subspecialty has evolved because the needs of infants and young children are fundamentally different from those of adults. Many of these important differences, however, are not obvious. Although the most apparent contrast is size, physiological differences related to general metabolism and to immature function of the various organ systems (including heart, lungs, kidneys, liver, blood, muscles, and central nervous system) are of major importance to the anaesthetist (Motoyama, 1990a). The purpose of describing these differences between children and adults is to highlight some of the difficulties encountered when providing general anaesthesia to children. Dentists involved in the care of children under GA should be aware of the demands imposed by child patients under day-stay procedures. This section highlights some of these differences and more comprehensive explanations can be found in textbooks of paediatric anaesthesia (Gregory, 1994b; Motoyama and Davis, 1990b).

Anatomical and physiological differences in children

The most obvious anatomical difference between children and adults is the ratio of body surface area to mass. Body surface area expressed as calories per hour per square meter, is considered to be the best criteria for determining drug dose, basal metabolic rate, and fluid and nutritional requirements. Although body surface area may be difficult to use clinically, it

can be said generally that if a child is growing within the 90th percentile, when he or she reaches 2 years of age, the surface area-mass ratio is approximately double that expected at full growth potential. The approximate weight and height can also be helpful in predicting the clinical response to drugs. The smaller the patient, the higher are the basal metabolic rate, the fluid requirements per hour, the oxygen consumption per minute, and the energy carbohydrate metabolism (Campbell et al. 1982).

Fluid maintenance and replacement is dependent upon body weight and total body water, as reflected by blood volume and extracellular fluid compartments. Total body water (TBW), calculated at about 80% of the body weight, is composed of extracellular fluid (ECF) and intracellular fluid (ICF). Children have approximately equal percentages of ECF and ICF (about 40% each), while adults during the process of growth and development lose about 50% of the ECF while maintaining the same ICF. Therefore, children have a larger ECF compartment than the adult patient. This will influence the pharmacokinetics of drugs used in outpatient general anaesthesia (Campbell et al. 1982). Approximately 10% of the TBW is in the blood volume, and this is calculated on the basis of body weight. In the child, up to the age of about 3 years, the blood volume is about 80 ml/kg, whereas in the adult it is about 70 ml/kg. This difference allows children to tolerate larger blood losses without change in clinical cardiovascular parameters (blood pressure and heart rate). Their blood volumes are larger and their peripheral vasculature responds better to fluid changes. However, this apparent advantage is often offset by reduced haemoglobin concentrations from ages 2 to 14 (Campbell et al. 1982). Children experience rapid fluid exchanges that can be reflected in periods of overhydration or relative dehydration. The latter is an important consideration as fasting is required prior to general anaesthesia. Dehydration can lead to hypotension on induction with anaesthetic agents. Rehydration in children, apart from replenishing proper fluid volume, may also minimise a febrile response during recovery.

Brain size and muscle mass are important anatomical differences to consider in children. Approximately 20% of the child's body weight consist of muscle mass, compared with 40% in the adult (Campbell et al. 1982). This difference may be related to the incidence of malignant hyperthermia, an uncommon genetic disorder that has been estimated to occur in children undergoing anaesthesia at a rate of 1:17,000 cases, compared with a 1:35,000 incidence in adults (Britt and Kalow, 1970). Therefore, there appears to be an inverse relationship between percentage of muscle mass and malignant hyperthermia. The brain size in the child gradually changes with increasing age. It occupies approximately one quarter of the total body surface area in infancy, and the ratio changes to 1:8 (brain/body surface) in the adult. Inhalational anaesthetic agents are transported to, and occupy a larger volume in the brain with respect of body mass, and result in quicker onset of action and more profound effect in children than in adults (Campbell et al. 1982).

Respiratory system differences

The child's upper and lower respiratory tract anatomy, which is different in size and function compared with the adult, can decrease the margin of safety in the child patient. The narrow nasal passages and glottic opening, commonly hypertrophied tonsils and adenoids, larger tongue, greater volume of secretions, and the narrowing of the trachea at the cricoid level can predispose the patients to respiratory obstruction. Upper airway obstruction, from a nasal mask constricting the nares, displacement of the tongue posteriorly, or depression of the floor of the mouth by an improperly placed mouth pack or retractor, will further accentuate the smaller anatomical features in a child. Generally, deeper anaesthetic planes with inhalational agents decrease the incidence of turbulent air flow caused by the smaller anatomical structures in the child patient. This is important but not as crucial in the adult, when intravenous agents are used and the larger airways can allow greater turbulence in airflow and lighter planes of anaesthesia (Campbell et al. 1982).

Lung volumes in infants, relative to body size, are similar to those in older children and young adults. These values increase in linear fashion with body growth. However, the ratio of alveolar surface area in the lungs to lung size is proportionally greater in children, allowing for greater alveolar ventilation per unit area. Greater alveolar ventilation is necessary for an adequate response to increased metabolic rate and oxygen consumption. The absolute values of lung functions in children, including functional reserve capacity (FRC), tidal volume (TV), vital capacity (VC), and alveolar ventilation (AV), are smaller even though the respiratory frequency is higher. The FRC, defined as the volume of gas remaining in the lungs at the end of a normal respiration and consisting of residual volume and expiratory reserve volume, is an important determinant of the speed of induction with inhalational anaesthetics as well as the speed of onset of hypoxia. The ratio of AV to FRC is significantly different in children compared with adults. The alveolar ventilation transports inhalational agents to the brain, while the portion of the gas remaining in the lung occupies the functional residual volume during normal breathing. In conjunction with a higher respiratory rate, this ratio difference helps explain the speed of induction in children. Because of the smaller FRC, if a child becomes obstructed or apnoeic, hypoxia can occur more rapidly than in adults (Campbell et al. 1982).

Cardiovascular system differences

General anaesthesia for the young patient with a structurally normal heart is often simpler than that for an older adult. This is because in infants and children cardiovascular stress responses are well established, coronary artery disease is rare, and life-threatening arrhythmias seldom occur. However, three considerations present the anaesthetist with special challenges: the normal cardiovascular physiology of paediatric patients without heart disease changes dramatically with age; the patient may have a congenital cardiac malformation; and, volatile and intravenous anaesthetic agents may have unique and adverse haemodynamic effects in the newborn infant. Details of these can be found elsewhere (Schieber, 1990).

In children, the cardiac rate is the most important determinant of cardiac output(Schieber, 1990). A sudden decrease in heart rate also results in a significant decrease in cardiac output, which in turn increases the rate of uptake of an inhalational anaesthetic agent. Since 40% of the cardiac output of the child patient (almost twice that of the adult) contributes to the cerebral blood flow, an increase in anaesthetic uptake during the slower perfusion of the pulmonary system causes a profound depressant effect. In general terms, changes in the heart rate and output are better compensated in a child than in the adult patient because of the larger extracellular fluid compartment and blood volume (Campbell et al. 1982). Cardiac output is high in children and blood flow is more directed to vessel rich tissues. The shorter induction period in children also increases the risk of obtaining a high concentration of inhalational agent in the myocardium and, consequently, in children some degree of systemic arterial hypotension is commonly seen during inhalational anaesthesia. However, a moderate fall in blood pressure due to loss of consciousness and stress, or due to a decrease in systemic vascular resistance, is seldom a major disadvantage in children (Olsson, 1995).

Pharmacological considerations

Pharmacokinetics, the process of absorption, rate of uptake distribution, localisation in tissues, biotransformation and elimination are all better understood in adults than in children. Many factors affect the pharmacodynamics of drugs. They include ionisation, lipid solubility, plasma binding, rate of metabolism, potency, tolerance of the specific agents, size of body water compartments and cardiac output and its relative distribution to the tissues (Campbell et al. 1982).

Minimum alveolar concentration (MAC) is defined as the concentration of an inhalational anaesthetic agent that prevents muscular movement in response to painful stimuli in 50% of patients. This indirectly indicates anaesthetic potency and is often influenced by age (MAC requirements decrease with increasing age), metabolic rate, and adjunctive drug therapy (Campbell et al. 1982).

Several important differences between adults and children can be identified in the area of pharmacology and paediatric anaesthesia:

- *Elevated anaesthetic requirement.* Children require larger doses of inhalational anaesthetics and relative larger doses of intravenous agents than adults to achieve the same effect. It has been hypothesised that this phenomenon may be related to a higher systemic metabolic rate or the larger water content of the young brain (Gregory, 1994c).
- *Rate of induction with inhalational agents.* The minute ventilation per kilogram of children is much greater than that of adults. In addition, the functional residual capacity per kilogram weight of the paediatric lung is significantly smaller. In light of these two facts, the basis for the important observation that children experience a more rapid inhalation induction of GA has been attributed to respiratory function (Gregory, 1994c).
- *Inhalational anaesthetic-vasoconstrictor interaction.* Dentists commonly use local anaesthetics containing vasoconstrictor agents such as adrenaline for control of post-operative pain or intra-operative haemostasis. These vasoconstrictors are cardiac stimulants that on occasion will cause cardiac arrhythmias. Inhalational agents such as halothane are also known to increase cardiac irritability and predispose to vasoconstrictor-induced arrhythmias when administered to adults. Children however, seem to be less susceptible to this drug interaction than adults (Karl et al. 1983). Other agents such as enflurane and isoflurane have less potential for cardiac irritability than halothane, and are acknowledged as safer for use with vasoconstrictors in older children and adults (Trapp, 1987).

Psychological considerations

Children scheduled for dental surgery under general anaesthesia quite often have already experienced emotionally traumatic dental visit(s) at which time their behaviour was unmanageable. Thus, a fear of doctors and health care environments may already have developed. The young child also has a normal fear of separation from parents and has not yet developed the communication skills that allow management by reassurance (Trapp, 1987).

Parental behaviour management is also an important consideration when paediatric anaesthesia is being planned. The presence of the parents during induction has been associated with both an increase or a decrease in emotional disturbance for the child (Steward, 1975; Campbell et al. 1982). However, some authors agree that in the majority of cases, the presence of one of the parents reduces the child's fear and apprehension during induction of anaesthesia (Campbell et al. 1982) (Nathan, 1989; McCormick and Spargo, 1996).

Guidelines and Regulations

The provision of general anaesthesia in dentistry is currently regulated by organisations or bodies specifically formed to monitor and improve safety and delivery of dental anaesthesia, each one addressing the needs for a particular institution, region or country. The most influential bodies affecting the provision of general anaesthesia for dentistry in Australia are:

- Australian and New Zealand College of Anaesthetists
- American Academy of Pediatric Dentistry
- Poswillo Report (United Kingdom)

Australian and New Zealand College of Anaesthetists

The provision of sedation and general anaesthesia for dental procedures is dependant on guidelines written by the Australian and New Zealand College of Anaesthetists, in association with the Royal Australasian College of Dental surgeons (Australian and New Zealand College of Anaesthetists, 1996). A number of policy documents from this College should be noted where appropriate in conjunction with this report (see Appendices No. 3, 4, 5 and 6). These include:

- Guidelines for the care of patients recovering from anaesthesia (Australian and New Zealand College of Anaesthetists, 1995a).

- Guidelines for the perioperative care of patients selected for day care surgery (Australian and New Zealand College of Anaesthetists, 1995b).
- Monitoring during anaesthesia (Australian and New Zealand College of Anaesthetists, 1995c).
- Recommended minimum facilities for safe anaesthetic practice in dental surgeries (Australian and New Zealand College of Anaesthetists, 1995d).

American Academy of Pediatric Dentistry

Guidelines for the elective use of conscious sedation, deep sedation, and general anaesthesia in paediatric patients were adopted jointly by the American Academy of Pediatric Dentistry and the American Academy of Pediatrics in 1985 (American Academy of Pediatric Dentistry, 1985). In June 1992, the American Academy of Pediatrics published a new document on paediatric sedation independently. The Sedation Subcommittee of the AAPD Clinical Affairs Committee, recognising the advances in monitoring technology and availability of new pharmacological agents, authored a revision of the 1985 guidelines in 1993 (American Academy of Pediatric Dentistry, 1993).

The 1993 revision requires continuous monitoring by an "appropriately trained individual". Continuous monitoring of oxygen saturation by oximetry, heart and respiratory rates, and blood pressure is required. These should be recorded intermittently on a time-based record. A pulse oximeter, precordial/pretracheal stethoscope, and blood pressure cuff are minimum monitoring devices; ECG, capnography, and temperature monitoring are desirable during sedation procedures. The child's head position should be checked frequently to ensure airway patency. Access to a defibrillator is desirable. Airway management and breathing equipment must be checked prior to each patient use. When general anaesthesia is being administered, drugs necessary for the treatment of malignant hyperthermia must be readily available. This must include sodium dantrolene which is the drug of choice for such a

condition. Patients receiving day-stay general anaesthesia must have an intravenous line in place, or have a person immediately available to establish one in paediatric patients (American Academy of Pediatric Dentistry, 1993).

After treatment has been completed, the patient must be observed in a suitably equipped recovery facility. This facility must have functioning suction apparatus and suction catheters of appropriate size, as well as the capacity to deliver greater than 90% oxygen and provide positive pressure ventilation for paediatric patients. The patient must remain in the recovery facility until cardiovascular and respiratory stability are ensured and appropriate discharge criteria have been met (American Academy of Pediatric Dentistry, 1993).

Poswillo Report (United Kingdom)

The Poswillo Report of March 1990 named after Professor D.E. Poswillo, Chairman of the Working Party, received praise for its efficient and careful analysis of the question of general anaesthesia, sedation and resuscitation in dental practice outside hospitals(Poswillo, 1990). The report was prepared for the Standing Dental Advisory Committee in April of that year and did not have immediate acceptance. This was due to the financial implications of the 60 recommendations for dental practice. Not only were dental practices providing general anaesthesia required to be registered and regularly inspected, but they were also required to purchase additional monitoring equipment, arrange for regular maintenance, service and periodic replacement of this equipment (Leader, 1991).

The Working Party encouraged dentists to advise patients of the benefits of alternative techniques to GA, such as inhalational and intravenous sedation. Throughout the report, the importance of trained auxiliary personnel was stressed, and the authors expressed concern that too few dental assistants in private practice received any formal training (Poswillo, 1990).

In regards to monitoring and equipment, the following recommendations were included in the report:

- An electrocardiogram, a pulse oximeter and a non-invasive blood pressure device are essential during monitoring of general anaesthesia.
- A capnograph be used where tracheal anaesthesia is practised.
- A defibrillator must be available.
- Equipment conforming to recognised standards should be purchased and installed, regularly serviced and maintained in accordance with the manufacturer's instructions.

As a result of this report, the number of general anaesthetics provided in private dental practices decreased due to the financial implications of such a document. Other recommendations included ongoing training for all dentists involved (and their teams) in resuscitation procedures, advanced life support skills for all dental anaesthetists, availability of all drugs listed in the report, and provision of written instructions to patients. Full description of this report can be found in the relevant paper (Poswillo, 1990).

Paediatric dentistry & general anaesthesia

Day-stay GA in paediatric dentistry

Several authors have published results on the use of general anaesthesia for paediatric dentistry. These have been listed in chronological order and they are summarised in Table 1.4. It is obvious from this table that most papers reporting on the use of general anaesthesia in children originate from the United Kingdom. Studies from Europe (Boulanger, 1990; Roeters and Burgersdijk, 1985; Tarjan et al. 1990; Vermeulen et al. 1991) and Scandinavia (Grytten et al. 1989; Persliden and Magnusson, 1980) have also been reported. It is interesting to note that most studies from North America are from the period between 1970s and 1980s (Enger and Mourino, 1985; Leagault et al. 1972; Lisagor, 1978; Nafiz, 1976), and only one study include more recent data (Bohaty and Spencer, 1992). Reports from Australia and New Zealand are few (Watson, 1979; Chippendale and Storey, 1988; Thomson, 1994). In summary, it is clearly seen that the use of GA in paediatric dentistry is far more common in the UK, Europe, and Scandinavia than the USA. In the US, sedation in one form or another seems to be the technique of choice when dealing with very young or uncooperative patients (Wright et al. 1991b).

Most of the studies confirm that the indications for treatment under general anaesthesia are extensive decay, behaviour management problems, medically compromised patients, extensive treatment, very young age, handicapped patients, anxiety, distance from home to a dentist, and a combination of these. The average number of patients treated*per* year in these reviews varied from 4 to 7852, but most papers do not give details as to how frequently services are provided. Several papers do not report clearly details of the dental procedures carried out (Boulanger, 1990; Holt et al. 1991; Keniry, 1974; O'Brien and Suthers, 1983; Ventura et al. 1981). Some studies show a trend toward more complex procedures and preventive items being provided (Bohaty and Spencer, 1992; Enger and Mourino, 1985;

Mitchell et al. 1985). One study reported changes over a ten year period and found a trend toward fewer restorations and pulpotomies, and more extractions, stainless steel crowns, and fissure sealants (Bohaty and Spencer, 1992). Some of the studies quoted in Table 1.4 were not included anywhere else, and they are listed here for proper referencing (Whitehead, 1971; Robertson and Ball, 1973; Barclay, 1974; Drummond et al. 1996; Mansson and Schroder, 1996; Shaw and Weatherill, 1996; Bryant et al. 1997).

Table 1.4: Studies reviewing the provision of paediatric general anaesthesia in dentistry.

Author(s) and year	Country	Period of study	Total No. patients	Day-stay No. patients	Mean age/ range	Type of treatment	2nd GAs (% pts.)	Comments
Rule et al. (1967)	UK	1959-65	225	225	2-15 years	Rests. & Exos	3.5 %	Retrospective study of 6 year period; 32% cases were 0-5 yrs
Whitehead (1971)	UK	1967-70	764	761	5-69 years	Rests. & Exos Surgical tx.	Not known	72% between ages 10-29; increased demand for GA
Legault et al. (1972)	Canada	4 years	300	300	5.8 years	Rests. & Exos	10.7 %	Private clinic; no follow up in 27.6%; comprehensive tx.
Robertson & Ball (1973)	UK	1970-72	100		3-Adult	Rests. & Exos	Not known	GAs for handicapped patients; 73% between ages 3-16
Barclay (1974)	New Zealand	1970	431	362	0-Adult	extractions	Not known	Survey of all NZ dentists in 1970
Keniry (1974)	UK	'6-month period'	1,307	1,307	0-16 years	comprehensive	17.7 %	Peak ages 4-8 years; approx. 2.3 extractions/patient
Nafiz et al. (1976)	USA	84 weeks	80		1.5-16 years	Rests. & Exos	Not known	

Table 1.4 (Continuation): Studies reviewing the provision of paediatric general anaesthesia in dentistry.

Author(s) And year	Country	Period of study	Total No. patients	Day-stay No. patients	Mean age/ range	Type of treatment	2nd GAs (% pts.)	Comments
Lisagor (1978)	USA	1975-76	4	?	2-25 years	Rests. & Exos	Not known	Combination of medical/dental procedures
Watson (1979)	Australia	1946-78	808		2-50 years	Rests. & Exos		Cerebral palsy patients; 396 patients aged between 5-18
Persliden & Magnusson (1980)	Sweden	1976-79	352	352	0-16 (6.5 median)	Rests. & Exos	Not known	Low morbidity (1.3%) of GA in hospital set-up
Ventura et al. (1981)	Israel	1972-78	4,000	All?	2-12 (average 5.0 years)	Rests. & Exos	Not known	Duration ranged 40-210 mins.; deals with GA technique
O'Brien & Suthers (1983)	Australia	12 year period	1,316 (in surgery)	1,316	1-15+ years	Rests. & Exos	Not known	50% of children aged 3-5 yrs; approx. 95% under 15 years
Enger & Mourino (1985)	USA	1977-82	200	? Average stay: 2 days	7.7 years	Rests. & Exos	Not known	Trend towards more complex treatment and prevention
Mitchell et al. (1985)	UK	1979-83	96	96	6-25+ years	Rests. & Exos	7.2 %	
Roeters & Burgersdijk (1985)	Nether-lands	1968-80	215	?	-	Rests. & Exos	10.2 %	Majority intellectually handicapped children

Table 1.4 (Continuation): Studies reviewing the provision of paediatric general anaesthesia in dentistry.

Author(s) And year	Country	Period of study	Total No. patients	Day-stay No. patients	Mean age/ range	Type of treatment	2nd GAs (% pts.)	Comments
McLaughlin et al. (1987)	UK	1960-84	4771	4771	1-79 years	Extractions in 99% of cases	Not known	Greater proportion of GAs for children
Chippendale & Storey (1988)	Australia (Melbourne)	1977-86	Not mentioned	Not mentioned	1-7 years	Extractions	Not known	80% decline in GAs since fluoridation
Grytten et al. (1989)	Norway	1975-83	1,067	1067 (private practice)	0-Adult	Rests. & Exos	Not known	Little change during period; 60% were aged <15 yrs
Boulanger (1990)	Belgium	-	46	46	1.5-14 years	Rests. & Exos.	Not known	2 main groups: below 6 yrs and older than 6
Smallridge et al. (1990)	UK	1987-88	3,623	836 (sample used)	0-16 (mean age 7)	Extractions	5.0 %	Mean age has decreased, and the number of exos/child has increased; increased demand
Tarjan et al. (1990)	Hungary	1981-89	180		2-16 years	Rests. & Exos		
Holt et al. (1991)	UK	1989	103	103	9 (+/-4.4yr)	Rests. & Exos; surgical tx.	Not known	Effective and efficient way for some children; low morbidity

Table 1.4 (Continuation): Studies reviewing the provision of paediatric general anaesthesia in dentistry.

Author(s) And year	Country	Period of study	Total No. patients	Day-stay No. patients	Mean age/ range	Type of treatment	2nd GAs (% pts.)	Comments
O'Sullivan & Curzon (1991)	UK	1984-87	80	80	2-11 (4.5 median)	Rests. & Exos	2.5 %	80% of children accepted tx. under LA at later visits
Vermeulen et al. (1991)	Belgium	1983-88	933		1-79 years (median=10)	Rests. & Exos	Not known	Most patients treated were children; increased demand
Bohaty & Spencer (1992)	USA	1978-80 1988-90	- -		6 (0-12 yrs) 6 (0-12 yrs)	comprehensive	Not known	Trend to fewer rests. & more exos.; age shift from 0-3 to 4-6
Holt et al. (1992)	UK	1990-91	7,852	7,852	0-15+ years	Extractions (at 3 hospitals)	Not known	Demand for GA is high; nearly 1/3rd of all GAs in children under 5 years of age
Thomson (1994)	New Zealand	1989-94	406	406	1.5-16 years	Rests. & Exos	4.2 %	Demand has greatly increased; extraction was most common
Mason & Holt (1995)	UK	1972, 1982 & 1992	202, 287, 465 respect.	202, 287, 465 respect.	0-15+ years	Rests. & Exos; surgical tx.	Not known	Demand has increased; more radical approach in younger children needed
Nunn et al. (1995)	UK	1983-93	265	264	0-26+ years	Rests. & Exos	12 %	Increased demand; need for radical approach under GA

Table 1.4 (Continuation): Studies reviewing the provision of paediatric general anaesthesia in dentistry.

Author(s) And year	Country	Period of study	Total No. patients	Day-stay No. patients	Mean age/ range	Type of treatment	2nd GAs (% pts.)	Comments
Drummond et al. (1996)	NZ	3-year period	48	48	Children (ages ?)	Rests. & Exos	Not known	41% parents made no changes to diets or oral care post GA
Mansson & Schroder (1996)	Sweden	Not stated	117	?	Children (ages ?)	Rests. & Exos	-	Two-year follow up; most children aged 6 or less
Shaw & Weatherill (1996)	UK	1990 1992	2,408 3,617	6,025	1-14 years	Extractions	Not known	Exos for 5 year olds or younger has changed from 44 to 38%; orthodontic exos more common
Bryant et al. (1997)	UK	1973, 1983, 1993, 1994	180, 504, 1348, 1352 respectively	178, 503, 1129, 1105 respectively	-	Dentoalveolar & maxillofac. procedures	Not known	Expansion of day-stay facilities needed
Wong et al. (1997)	UK	1985-95	586	566	0-17 years	Rests. & Exos	14 %	Trends of patients travelling longer for treatment
Harrison & Roberts (1998)	UK	1991-96	1063	?	1-24 years	Rests. & Exos	Not known	More extractions in chronically sick children

Characteristics of children undergoing GA in dentistry

Several studies report on the use of general anaesthesia in paediatric dentistry at major teaching hospitals or institutions (Bohaty and Spencer, 1992; Boulanger, 1990; Holt et al. 1991; O'Sullivan and Curzon, 1991; Thomson, 1994). Most children attending these institutions are first assessed in a paediatric outpatient clinic. This assessment usually includes a medical history, clinical and radiographic examinations and appropriate tests or investigations if medically compromised. A provisional treatment plan is usually formulated and advice on prevention is given to the parents. The characteristics of these children are discussed in several studies, with the most relevant topics of interest shown in Table 1.5.

Patient details	**Demographic characteristics**	**Treatment provided**	**Other**
Gender	Place of residence	Extractions	Medical condition
Age	Reason of referral	Primary dentition	Follow up
Ethnicity	Source of referral	Secondary dentition	Need for further GA
Health insurance	Waiting time	Surgical procedures	GA morbidity

Table 1.5: Characteristics of children undergoing general anaesthesia for dentistry.

Most studies agree that the main reason for providing GA in children is caries or its effects (Holt et al. 1991; Holt et al. 1992; Mason et al. 1995; McLaughlin et al. 1987; O'Sullivan and Curzon, 1991; Smallridge et al. 1990; Vermeulen et al. 1991). Only seven studies provided data on the number or percentage of patients requiring GA due to caries, and these are summarised in Table 1.6.

Authors & Year	No. patients	Caries (% patients)
McLaughlin et al. (1987)	4771	99%
Smallridge et al. (1990)	836	95%
Holt et al. (1991)	103	68%
O'Sullivan & Curzon (1991)	80	84%
Vermeulen et al. (1991)	904	83%
Holt et al. (1992)	7852	86%
Shaw & Weatherill (1996)	559	54%

Table 1.6: Percentage of patients treated under general anaesthesia due to caries.

The source of referral of children requiring treatment under GA varies extensively with the country of origin of the study involved. A major determinant is the health care system in force for each place. For instance, in the UK where most dentistry is carried out through the National Health Service (NHS), most referrals are from GP dentists as well as the School Dental Service (Mitchell et al. 1985; Smallridge et al. 1990; Holt et al. 1992; Nunn et al. 1995). In contrast, the study from Belgium found that GP dentists and doctors made the most important referral groups, followed by self referred patients (Vermeulen et al. 1991). Details of the referral patterns were available for a few studies, and these are shown in Table 1.7.

Authors & Year	Referral patterns of patients (%)*					
	No. patients	GP dentists	SDS	Self	Doctors	Other
Keniry (1974)	1,307	52	13	32	1	2
Mitchell et al. (1985)	96	47	33	6	6	7
Smallridge et al. (1990)	836	54	23	15	-	8
Vermeulen et al. (1991)	889	45	1	18	28	8
Holt et al. (1992)	7,852	52	23	16	-	8
Nunn et al. (1995)	265	44	28	5	12	10
Wong et al. (1997)	586	52	15	15	8	5

Table 1.7: Source of referrals for children requiring dental general anaesthesia.

* Note that percentages quoted are approximations only

In regards to the treatment provided under GA, there appears to be an increasing trend to implement more radical treatment plans for this specific group of children (Nunn et al. 1995). Several studies report an increase in the number of teeth being extracted and a decrease in the number of restorations, at least in the primary dentition. The restorative procedures that were most successful in terms of durability were stainless steel crowns and pulpotomies in the primary dentition (O'Sullivan and Curzon, 1991). This is consistent with studies on the longevity of restorations in the primary dentition (Messer and Levering, 1988; Roberts and Sherriff, 1990; Kilpatrick, 1993). Results of treatment provided in the permanent dentition show that amalgam is still the material of choice when restoring permanent molars. GA is also used with frequency for the extraction of permanent teeth, either carious or for orthodontic reasons. A summary of findings of treatment provided is seen in Table 1.8. The data in this table however presents several difficulties. In some cases the standard deviations for each value were nearly as large as the value itself for a determined parameter. Secondly, several studies did not distinguish between primary and

secondary dentitions and, it is not clear how some of these values were calculated, that is, out of the total number of patients in the whole study or the total number of patients receiving that particular procedure.

Authors & Year	No. pts.	Mean age	Mean number per patient						
			1ry exos	2ry exos	1ry rests	2ry rests	SSC	Pulpot	FS
Rule et al. (1967)	225	?	3.8	2.8	3.5	4.4	-	-	-
Leagault et al. (1972)	300	5.8	2.1 (1ry & 2ry)		4.1 (1ry & 2ry)		1.1	0.6	-
Enger & Mourino (1985)	200	7.7	3.7 (1ry & 2ry)		6.1 (1ry & 2ry)		3.0	0.7	-
O'Sullivan & Curzon (1991)	80	4.5	4.0 (1ry & 2ry)		2.7 (1ry & 2ry)		2.6	1.8	0.8
Bohaty & Spencer (1992)	-	6.0	4.8 (1ry & 2ry)		5.9 (1ry & 2ry)		7.4	5.6	1.2
Thomson (1994)	406	5.1	3.5 (1ry & 2ry)		2.9 (1ry & 2ry)		-	-	-
Nunn et al. (1995)	265	?	3.6	2.9	3.5	5.0	-	1.0	4.0
Wong et al. (1995)	586	?	2.4	0.5	2.7	1.0	0.1	0.4	-

Table 1.8: Summary of studies that provide comprehensive paediatric dental treatment. Figures given as mean procedure per child.

Abbreviations: number of patients (No. pts); primary (1ry); secondary (2ry); extractions (exos); restorations (rests); stainless steel crowns (SSC); pulpotomy (pulpot); fissure sealants (FS).

Surgical procedures carried out in children varied significantly in the proportion of patients requiring such treatment. The most common procedures appeared to be surgical removal of supernumerary teeth, surgical exposures of impacted/unerupted teeth, and minor soft tissue surgery. A summary of the studies that reported surgical treatment in children is given in Table 1.9.

Authors & Year	No. pts. in study	No. surgical procedures	Procedures performed
Rule et al. (1967)	225	26 (11.5%)	Not stated; age range between 5-15 yrs
Keniry (1974)	1,307	17 (1.3%)	Not stated; age range between 6-14 yrs
Holt et al. (1991)	103	46 (44.7%)	Mostly surgical exposures (20), supernumeraries (11) and extractions (9)
O'Sullivan et al (1991)	80	1 (1%)	Not stated. Mostly restorative and simple extractions carried out.
Mason et al (1995)	954	212 (22.2%)	200% increase of surgery related to orthodontics between 1982-1992
Wong et al (1997)	586	100 (17.1%)	Supernumeraries, apicectomy, cyst removal and diagnostic implant

Table 1.9: Frequency of surgical procedures carried out in children under general anaesthesia.

Abbreviations: number (No.); patients (pts.)

Significant proportions of children that require GA are medically compromised or have a physical or intellectual handicap. The literature reports that between 6% (Leagault et al. 1972) and 79% (Harrison and Roberts, 1998) of children have some medical or a disability background. However, this wide variation highlights the fact that many studies do not give specific details of the actual background of these children. For instance, a child that may suffer from mild episodic chronic asthma may be grouped as a chronically sick patient, and perhaps included with other more severe medical conditions (such as cyanotic cardiac defects, severe metabolic disorders or oncology patients). A summary of the proportion of children with medical backgrounds is given in Table 1.10.

Authors & Year	No. patients in study	% patients
Rule et al. (1967)	225	22%
Leagault et al. (1972)	300	6%
Keniry (1974)	1,307	20%
Persliden & Magnusson (1980)	352	17%
Enger & Mourino (1985)	200	41%
Grytten et al. (1989)	1,067	14%
Holt et al. (1991)	103	31%
O'Sullivan & Curzon (1991)	80	20%
Vermeulen et al. (1991)	933	34%
Holt et al. (1992)	7,852	8%
Nunn et al. (1995)	265	68%
Wong et al. (1995)	566	60%
Harrison & Roberts (1998)	1,063	79%

Table 1.10: Proportion of patients with medical conditions per study.

Paediatric Dentistry in Australia

Dental Caries of children in Australia

The prevalence of caries in Australian children has decreased markedly since its peak in the 1950s. Australian children, like many children in industrialised countries had considerable experience of caries in the post-Second World War period. By 1977 considerable improvement in caries experience had already occurred (Spencer et al. 1994). Data on the dental health of Australian school children who are registered with the school dental services have been reported for the period 1977 to 1986 (Carr, 1988; Commonwealth Department of Health, 1987). Significant features included a continued decline in caries experience as defined by the number of decayed, missing and filled teeth in both the primary dentition (dmft index) and permanent dentition (DMFT index). A change was also noted in the distribution of caries experience within the child population in Australia, with increasingly smaller percentages of children accounting for greater proportions of total disease experience (Davies et al. 1997).

Figures 1.1 to 1.5 have been taken from a recent study on the trends in dental experience of school children in Australia (Davies et al. 1997). Figure 1.1 presents the caries experience for both primary and permanent dentition for school children aged 5 to 12 years for 1993. The mean dmft for 5-year olds was 1.80. There was a slight increase across age groups until a peak at 8 years (dmft = 2.21). Primary caries experience then declined across older age groups as exfoliation of deciduous teeth, especially primary molars which are more likely to have caries, becomes more pronounced. The mean DMFT increased across age groups to a mean of 1.10 by the age of 12 years. However, it is readily apparent that most caries occurs between the ages of 5 and 12 years and is associated with the primary rather than the permanent dentition (Davies et al. 1997).

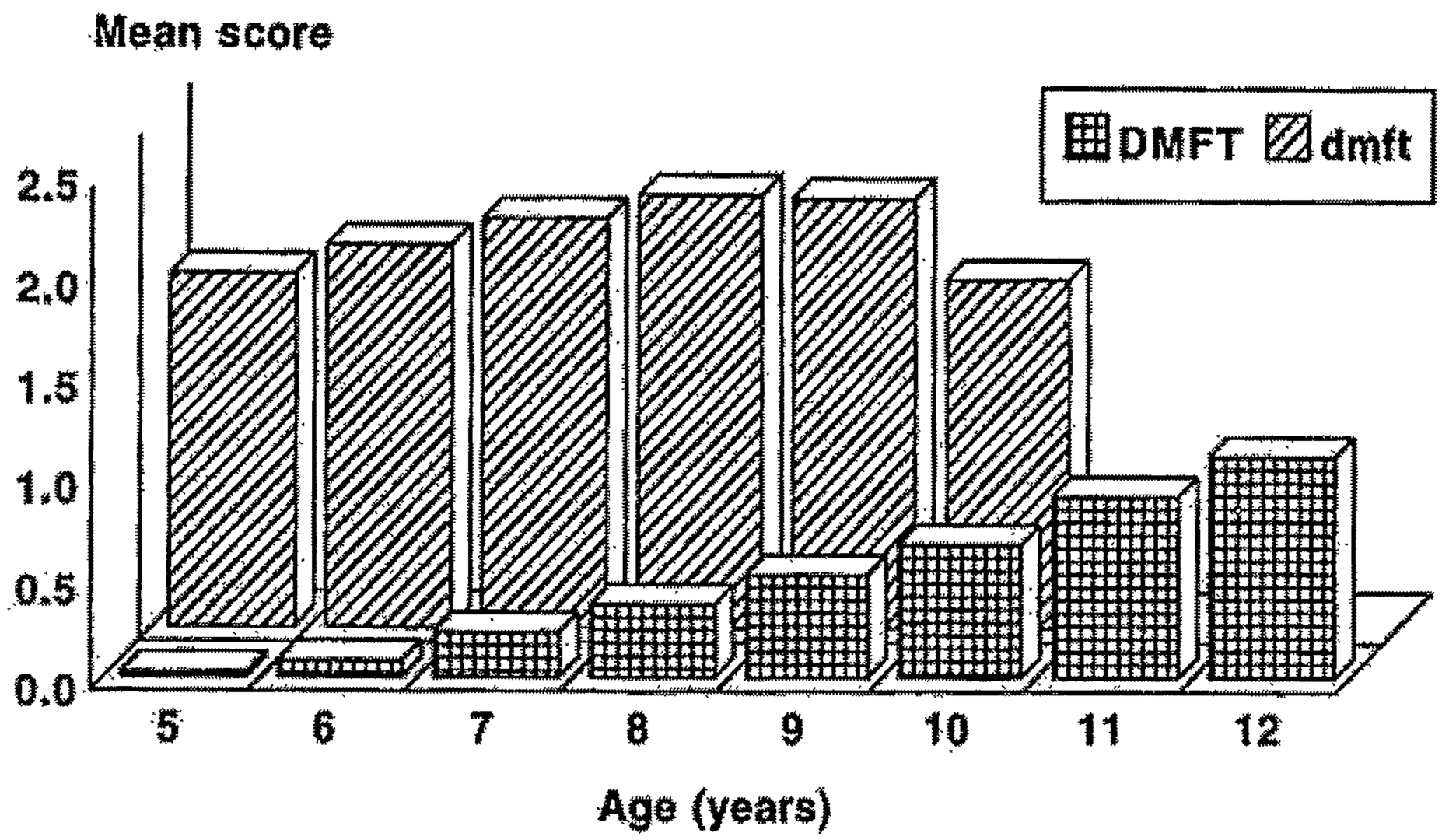

Figure 1.1: Mean dmft and DMFT scores for children aged 5 to 12 years in Australia in 1993. Victorian 11-12 year old children excluded due to small sample, dmft scores plotted only to age 10. Figure reproduced from study by *Davies, Spencer, et al. 1997.*

Figures 1.2 and 1.3 compare data for 1993 to previous years by presenting the 1993 caries experience for 6 and 12 year olds as part of a time trend from 1977 to 1993. Caries experience for 6-year old children was 3.13 in 1977 which declined to a dmft of 1.90 by 1993. There were no significant differences (rate of decline in caries) in mean dmft scores between 1986 and 1993. It can also be seen that caries in the primary dentition is dominated by untreated decayed teeth, although that domination reduced from 1977 to 1993. There were low numbers of teeth missing due to caries. In contrast, there was a continued decline of the DMFT index in 12-year olds over the period 1977 to 1993. The DMFT for 12-year olds was 4.79 in 1977, which declined to 1.10 by 1993 (Davies et al. 1997).

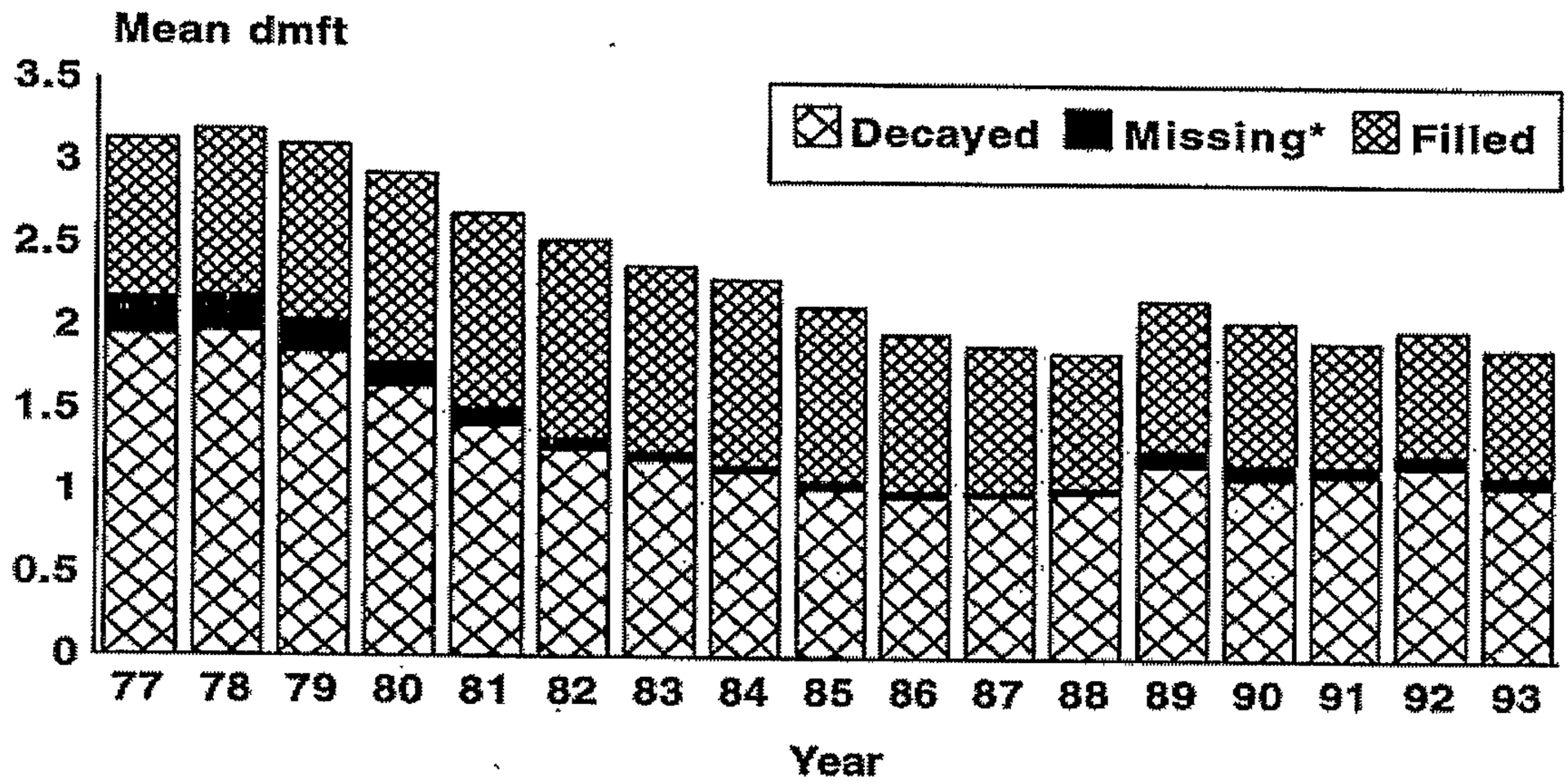

Figure 1.2: Mean dift and dmft components in 6 year old children in Australia from 1977 to 1993. The "i component" in dift refers to teeth 'indicated' for extraction from the period between 1977-1988; dmft for 1989-1993. Figure reproduced from study by Davies & Spencer, et al. 1997.

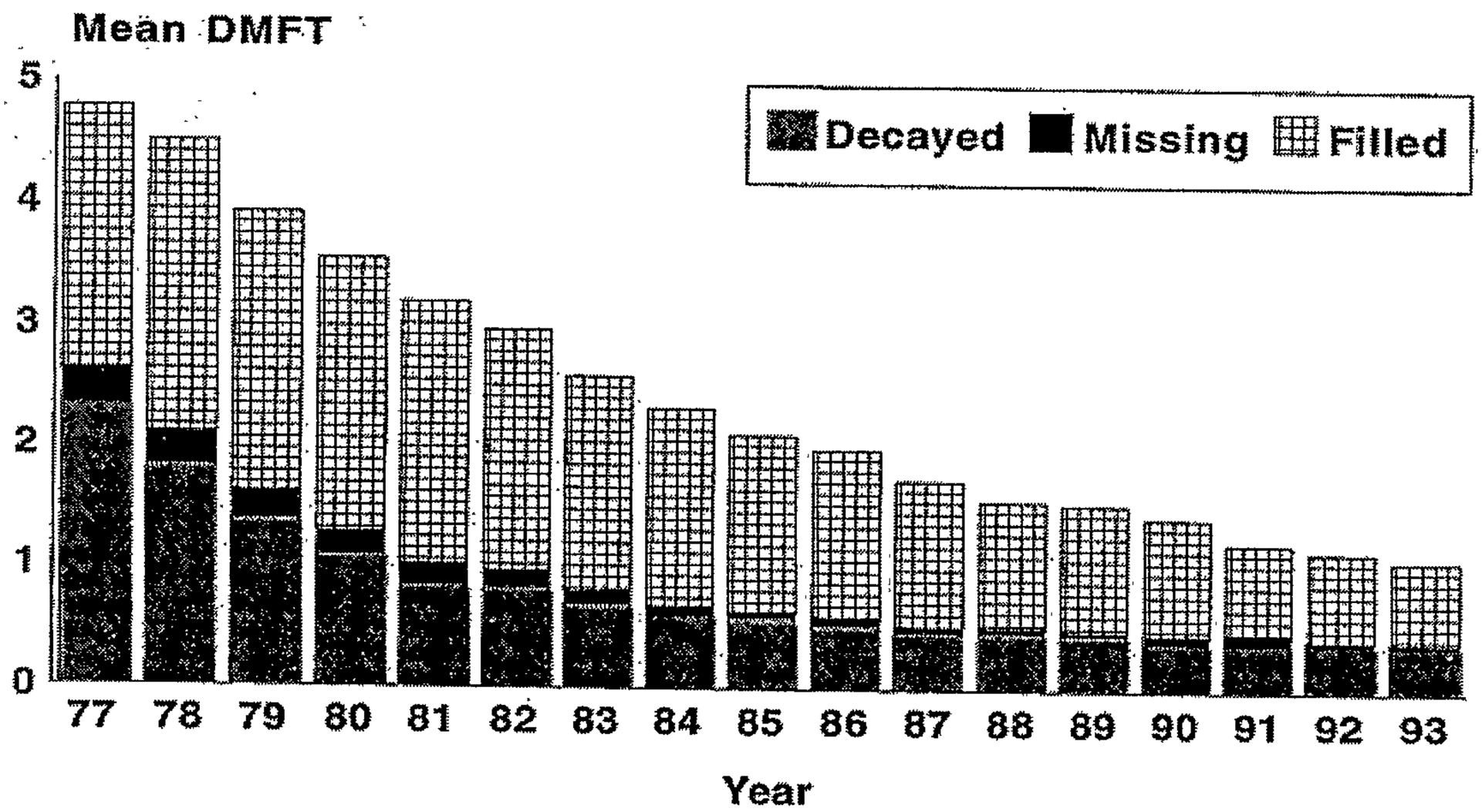

Figure 1.3: Mean DMFT components in 12 year old children in Australia from 1977 to 1993. Figure reproduced from study by *Davies, Spencer, et al. 1997.*

Figure 1.4 shows frequency distribution of dift and dmft for 6-year old children for the years 1977, 1985 and 1993. There has been little change over time in the shape of the distribution apart from an increase in the percent with a zero dmft from 33.1% in 1977 to 53.2% in 1993. However, the elevated levels of primary caries experience relative to current levels of caries experience in the permanent dentition, and the shape of the disease distribution indicate a substantial burden of disease within the community. For instance, 21% of 6-year olds had a dmft of 4 or more in 1993, and 35% had a dmft of 2 or more (Davies et al. 1997).

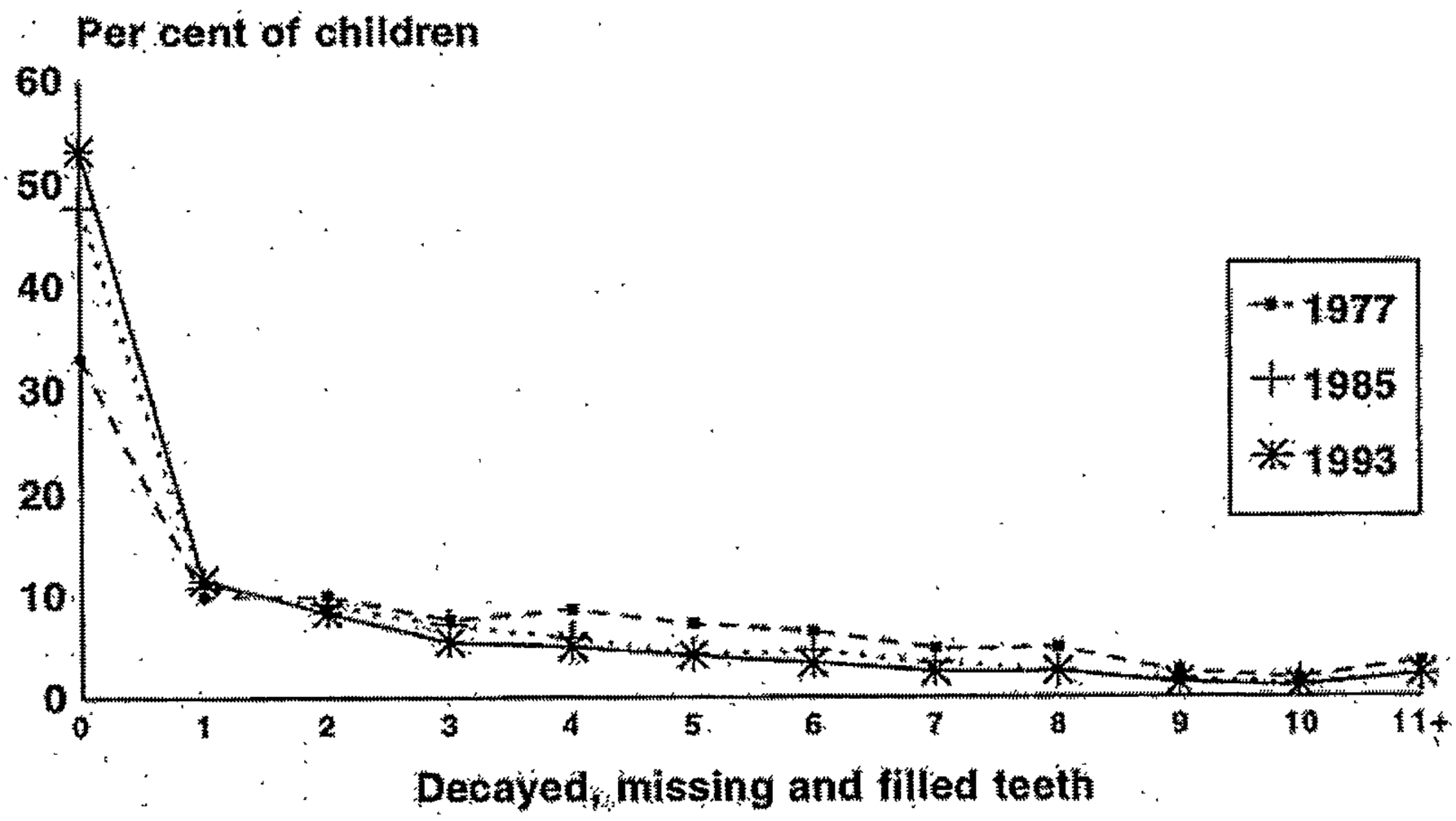

Figure 1.4: Distribution of dmft for 6 year old children in 1977, 1985, and 1993. Note dift for 1977 and 1985, dmft for 1993. Figure reproduced from study by *Davies, Spencer, et al. 1997.*

The pattern of change in the distribution of disease from 1977 to 1993 was different in the permanent dentition of 12-year old children. Figure 1.5 shows the frequency distributions for DMFT scores of 12-year olds for the years 1977, 1985 and 1993. In 1977 only 10.5% of children had no caries experience in their permanent teeth, with the most common score being a DMFT = 4. By 1985, the distribution was bimodal with the most common DMFT score of zero in 34.6% of 12-year olds, and a second peak at DMFT of 4 in 15.4% of children. 1993 had increasing numbers of caries free 12-year olds (55.8%), with a small minority of children showing high levels of disease. In this respect, 65.1% of 12-year olds had a DMFT of four or more in 1977, this percentage decreasing to 27.7% in 1985 and 11.6% in 1993 (Davies et al. 1997).

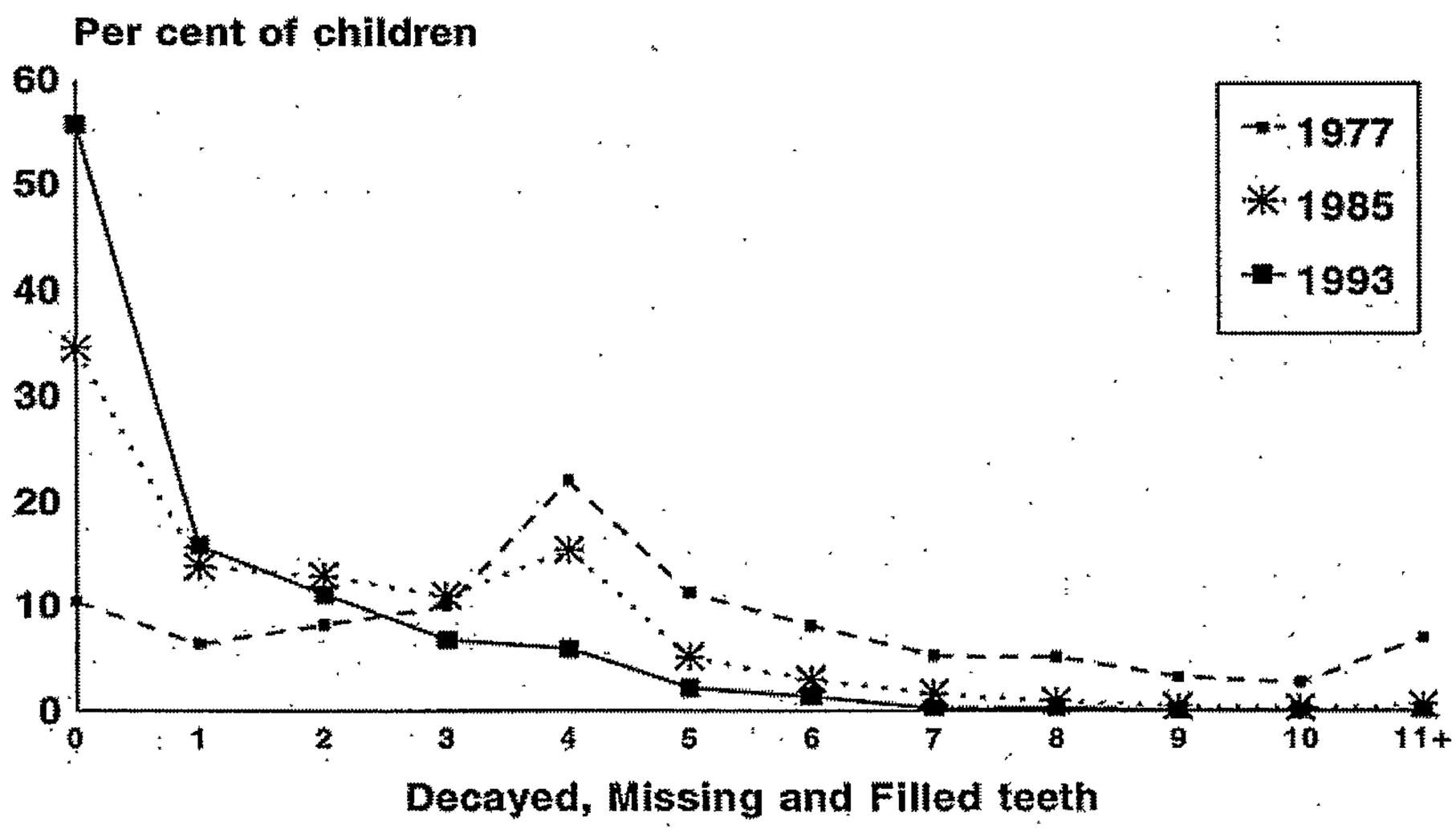

Figure 1.5: Distribution of DMFT for 12 year old children in 1977, 1985, and 1993. Figure reproduced from study by *Davies, Spencer, et al. 1997.*

The substantial reduction of caries prevalence in school children in Australia from 1977 to 1993 represents a significant achievement in dental health within Australia. The apparent step up in the caries experience in 1989 reflected a change in the survey methods, particularly sampling strategies and, to a minor extent, the addition of missing teeth in the index. There is an indication that caries experience in the primary dentition for 6-year olds has plateaued as observed in other countries (Downer, 1992; Rugg-Gunn et al. 1988).

Data for the primary dentition presents a less favourable profile of caries experience than for the permanent dentition, with relatively stable disease patterns and a comparatively high proportion of the dmft index being made up of the untreated decay component of the dmft index. Despite the improvements in the ratio of decayed to filled teeth, young children still enter school with a high level of untreated decay. This result highlights a priority for both preventive and therapeutic care at an earlier age than routinely provided by school-age based dental care programmes. Furthermore, this would suggest that there is a need for targeting interventions and services at the minority of children who still have substantial caries experience (Davies et al. 1997).

Nursing Caries

Nursing caries is a specific form of rampant caries in the primary dentition of infants and young children. Typically, the condition is found in an infant or toddler who frequently falls to sleep sucking a nursing bottle filled with sweetened fluids (including milk), a pacifier dipped in sweetener, or who has a prolonged demand breast feeding habit. In most cases, nursing caries is a form of overindulgence rather than neglect. Frequent intake, prolonged oral clearance, and the lowered circadian flow of saliva at night all appear critical to the development of nursing caries (Johnston and Brearley Messer, 1994; Ripa, 1988; Davenport, 1990).

Determining the true prevalence of nursing caries is difficult since most children affected are of pre-school age and not accessible for examination (Ripa, 1988; Davenport, 1990). Furthermore, data collected may be from biased samples, for instance, children whose parents are aware of an existing dental problem are more likely to present for examination (Ripa, 1988; Kamp, 1991), or different diagnostic criteria may affect the assessment of prevalence. The reported prevalence of nursing caries in western countries is less than 5 per cent (Ripa, 1988; Davenport, 1990; Kamp, 1991). Comparatively, Australian studies have reported prevalences ranging from 2.6% to 6.4% (Calache and Wright, 1987; Brown et al. 1985; Wyne et al. 1991). In summary, determining the number of children affected by nursing caries is extremely useful as approximately two thirds of the children seen in this study were of preschool age. These are the typical children who may require general anaesthesia.

Water Fluoridation in Australia

Since the commencement of water fluoridation in Australian State capital cities in 1964 and The Tasmanian Royal Commission in 1968 (Crisp, 1968), water fluoridation was promoted as the cornerstone of public health policy for the prevention of dental caries in Australia. However, in recent years questions have been raised about the effectiveness of water fluoridation. In particular, the need for this public health measure when children's caries levels are at historically low levels, and other fluoride vehicles (particularly toothpaste) are widely available (Diesendorf, 1986; Colquhoun, 1990; Diesendorf et al. 1997).

In Australia today nearly two-thirds of the population resides in an area with adjusted fluoride levels in the water supply (Commonwealth Department of Health, 1984). Between 1964 and 1977, seven of the eight capital cities implemented fluoridation of public water supplies. Over the past 50 years, since the first fluoridation project in North America, there has been an accumulation of epidemiological evidence that supports the benefit of water

fluoridation. In Australia, the Tamworth study, which began in 1963 with a pre-fluoridation survey and carried through to 1988, reported on the decrease in caries in 6- and 12-year old residents in the fluoridated city (Barnard, 1989; Barnard, 1990). Several other pre-1980 studies have also firmly supported the benefits of fluoridation in Australia (Videroni et al. 1976; Carr, 1972; Carr, 1976). Current research has shown water fluoridation to be associated with reduced caries experience in Australian children (Spencer et al. 1996). Since the NHMRC review of water fluoridation in 1991, three Australian studies have examined the association between caries experience and exposure to water fluoridation: Western Australian children (Riordan, 1991); New South Wales children (Patterson and Weidenhofer, 1993); and, South Australian and Queensland children (Slade et al. 1995; Slade et al. 1996a; Slade et al. 1996b).

The number of vehicles through which exposure to fluorides may occur has increased in recent decades. In Australia the main fluoride vehicles are water fluoridation, toothpaste with fluoride and fluoride supplements. The changing pattern of fluoride exposure has accentuated the need to determine the relative benefits of fluoride from water versus other contemporary sources. Over 95 per cent of toothpaste marketed contains fluoride. Analysis of the interaction of brushing frequency with lifetime exposure to water fluoridation has indicated that even among children brushing regularly there is a 24% advantage of lifetime exposure to water fluoridation over those with no exposure. This finding indicates that: water fluoridation has an additive effect with fluorides from other sources in the prevention of dental caries in children; and, neither toothbrushing with a fluoride-containing toothpaste nor water fluoridation make the other fluoride vehicle redundant in the prevention of caries (Davies, 1993).

In summary, water fluoridation has had a significant effect in caries reduction in children since its introduction. However, the multicultural nature of the child population in Sydney,

and the fact that many of these children were born overseas means that not all children benefit from water fluoridation. This observation supports the fact that only a small proportion of children are responsible for most of the decay experienced by Australian children (Davies et al. 1997; Widmer and Mekertichian, 1996).

Providers of Child Dental Care

The delivery of dental care to children in Australia is through both public and private sectors. Many children of school age have access to free dental care either through dental school clinics, dental therapist colleges and major teaching dental hospitals. The more recent introduction of a screening program in NSW called "Save Our Kids Smiles" or SOKS for short has altered the number of children that receive a dental examination. In NSW dental care for children in private practice is mainly provided by general dentists and only a small number are seen by paediatric dentists (only three registered specialists in the private sector in NSW). It is therefore the objective of this section to briefly describe who provides dental care for children in NSW and specifically for the Sydney metropolitan area.

It is difficult to determine with accuracy the proportion of children seen by different dental personnel in Australia. Previous national surveys have estimated the place of the last dental consultation by children between the ages of 2 to 14 years for a 12 month period. For the year ending in April 1995, a total of 574,800 children (out of a possible 1,120,700 children) consulted a dental professional in NSW. Of these, 58% were seen in private surgeries; 32% were seen by the School Dental Service; 5% were seen at a community dental clinic; 4% were seen in a hospital and 0.5% by other (Szuster and Spencer, 1997).

SOKS Program

While water fluoridation and the use of fluoride toothpaste have led to a dramatic improvement in the dental health of the general population there is still a large number of

adults and children who experience unacceptable amounts of tooth decay and gum disease. These are historically those who do not access regular dental care. To improve the dental health of children, the NSW Health Department joined forces with the Department of School Education, the Catholic School Commission and private dental practitioners to launch the Save Our Kids Smiles (S.O.K.S.) program. This program was previously referred to as the Dental Assessment and Prioritisation Program (D.A.P.P.). This particular program was trialed in some centres of NSW and the improvement in oral health in these communities was considerable. It was found that particular attention needed to be paid to children in lower socio-economic groups, Aboriginal children and children from non-English speaking backgrounds. The program was aimed to children in Kindergarten and grades 2, 4, 6, and 8. The emphasis of the S.O.K.S. program is on prevention and it does not give each child a full dental examination. It aims to give them a caries-risk assessment and should a child require treatment parents were actively encouraged to visit their family dentist (Dental Health Branch, 1996a).

The SOKS program began in NSW schools at the beginning of 1996. Prior to its introduction only 26% of children aged between 5 and 14 years were treated in public dental clinics (and 74% were not seen; data from year 1993). Of these 26%, nearly two thirds had been seen by the service within the last 12 months, and only 39% were new to the service. This meant that those patients that sought treatment or those that were highly motivated were seen and treated. Those with low literacy skills, or language difficulties, or from low socio-economic backgrounds were rarely seen, despite being those with the largest amount of decay. Data from The National Oral Health Survey showed that 36% of children sought care in the private sector while 5% were using both the private and the public system. Furthermore, 43% of children had no access to dental care at all (Dental Health Branch, 1996b).

Initial results from the SOKS program found that 58% of children had no caries experience and 42% had some need of dental treatment (data for year 1996). Of those children that required treatment 4% were considered to be in need of immediate attention, and 32% had untreated disease or were considered to be at risk of further dental disease (NSW Dental Health Branch, 1997).

Private dentists involved in the treatment of children

It is apparent from the figures given by the SOKS program that a significant proportion of children are seen in private practices by private dentists. The exact numbers are difficult to estimate but a study found that 335,300 children aged 2 to 14 (out of a total of 1.12 million children in NSW) attended a private dentist for the year ending in April 1995 (Szuster and Spencer, 1997). Unpublished data in NSW has shown that general dentists (ADA members) do not see a lot of children when compared to their overall patient load. In contrast, dentists that are members of the Australian and New Zealand Society of Paediatric Dentistry (ANZSPD) see significantly more children than their ADA counterparts (Kilpatrick et al. 1998).

Services at Westmead Hospital

Provision of dental treatment for children at The Westmead Dental Clinical School is mainly provided through the department of Paediatric Dentistry. Dental treatment has been free of charge to all children up to the age of 16 years since the opening of the hospital in 1983. However, due to cuts in funding by the federal government and the increased demand in recent years, this service has been restricted to children within the Western Health Area and to those requiring specialist care. The introduction of newer screening programs such as SOKS has further modified how patients access this hospital.

All new patients are assessed by general dentists or dental therapists within the hospital or by the School Dental Service. Most children are treated at the paediatric dentistry department, but a significant number is diverted to general dentists and therapists within other departments, or to undergraduate dental students of The University of Sydney. These are children that require straight forward dental needs and do not present management problems during the delivery of dental care.

Paediatric Dentistry Unit

The department of Paediatric Dentistry is made up by two senior consultants in Paediatric Dentistry, one senior lecturer, several registrars at different levels of training in the discipline, visiting paediatric dentists and resident dentists working a certain number of hours per week. The main purpose of this department is to provide specialist paediatric dental care to children with special needs. This usually involves treatment of children who are medically compromised, children that have suffered dento-alveolar trauma, children with management difficulties or those with high levels of caries, and children that require surgical treatment due to soft tissue lesions, trauma or orthodontic related surgery. A significant amount of interceptive orthodontic treatment is also carried out as well as routine orthodontic work, mainly through the department of Orthodontics. This wide variety of services requires the constant involvement of specialists in different disciplines of Dentistry. This multi-disciplinary approach assures adequate planning and delivery of dental treatment.

In order to deliver such a wide scope of dental treatment to children, several management techniques are used. These range from simple behavioural methods to different levels of sedation. The most common form of sedation used in the unit is relative analgesia or nitrous oxide sedation. Other forms of sedation include oral sedation and IV sedation but these are used less regularly. Day-stay General anaesthesia is provided on a regular basis and approximately 18-22 patients are seen every week for the delivery of dental treatment.

Description of GA process

The provision of general anaesthesia (GA) in paediatric dentistry is considered a specialised service and all patients follow as similar protocol which involves several steps. First, all referrals are booked through a consultant's clinic to assess the need for GA. However, a significant number of patients requiring this service access the hospital through the emergency department. The indications for GA have already been discussed and this section will describe the process of having a GA at this hospital.

Initial consultation

All patients undergoing GA have an initial consultation at which time a thorough medical and dental history is taken. This may involve liaising with the referring dentist or medical practitioner in order to obtain a more detailed history. Patients that are significantly medically compromised may required further tests or investigations to ascertain their fitness for GA. This usually involves a pre-anaesthetic assessment for further evaluation. A family and social history are also important as it provides other relevant information, such as history of complications to anaesthesia in the family, place of residence, issues of guardianship and consent, parental expectations, etc. A thorough clinical examination, dental charting and provisional treatment plan then follow, and these are discussed with the parent/caretaker. A relevant radiographic examination is carried out at this time, and whenever possible an OPG is requested for children having a general anaesthetic.

Other issues related to GA are also discussed at this appointment. The most important issue is appropriate and informed consent. This involves a detailed explanation of the procedure to be carried out and any possible complications that may arise. The consent form is signed by the parent or legal guardian and witnessed by the dentist. All patients are expected to be taken home by private transport whenever possible. If no appropriate arrangements can be made, the GA time is rescheduled. Preferably, all children should be accompanied by two

adults to facilitate the trip back home, and no other children should be present to ensure full attention is given to the child undergoing the GA.

Fasting is required for all patients undergoing general anaesthesia. Generally all children should be fasted 4 hours for clear fluids and 6 hours for solids or milk. In practical terms, this means that all children having a morning GA session should fast from the night before. In order to expedite the process, younger children are placed first in the list as they tend to dehydrate and become more irritable faster. Children with significant medical histories are also booked earlier to allow a more prolonged recovery if necessary.

Admission to day-stay unit

All child patients admitted to hospital are booked at one of two starting times: 7 am or 11 am. Admission is carried out first by reception staff and then by nursing staff from Dental Theatres. All children are examined for fitness for GA by medical nurses and this is followed by an anaesthetist assessment. At this time the presence of an interpreter may be required to assist with any questions by medical and dental personnel. Then the parents are requested to change their child into a hospital gown and they are assigned a bed in the recovery unit. The need for premedication is determined and this is usually in the form of a combination of oral paracetamol and midazolam. If intravenous induction is being considered, a topical anaesthetic cream (e. g. EMLA® patch) is placed on the dorsum of the hand. One parent is allowed to accompany the child during this process. Once the admission is complete, the dentist carrying the procedure on the day discusses once more the procedure with the parent or guardian. This may be altered on the day as the child may have developed other dental problems, especially if patients have waited several months in the waiting list.

Induction and maintenance of GA

In order to minimise separation anxiety parents are allowed to accompany their children up to the time of induction of anaesthesia. The mode of induction usually depends on the

anaesthetist, although some children/parents may have a specific preference. Inhalational induction is probably used more frequently in children, and a mixture of sevoflurane with nitrous oxide/oxygen is usually given. Other children may undergo intravenous induction with thiopentone or with propofol (older children). Induction and preparation of the patient for the operation is carried out in a preanaesthetic room directly attached to the operating theatre. An intravenous line is obtained via a cannula as soon as induction is achieved. Nasal intubation is carried routinely to facilitate access to the oral cavity. This is achieved by the use of nasal Rae tubes which are preformed and come in different sizes. These tubes allow all anaesthetic hoses to be directed away from the mouth and therefore facilitate access. The need for muscle relaxants in children undergoing dental general anaesthesia varies, and this is subject to the anaesthetist preference.

All patients are classified according to the American Society of Anaesthetists classification (Owens et al. 1978), with most children being ASA I or II. A selected number of patients may be ASA III or E (see Apendix No. 1). Anaesthesia is maintained usually with a mixture of halothane and nitrous oxide/oxygen although other drugs are also used. Monitoring of the patients is in accordance with current guidelines for the provision of anaesthesia (see Appendix No. 5). Once the dental procedure is complete the patient is allowed to become conscious and regain his/her protective reflexes before extubation. Oxygen is delivered through a mask and the patient then transferred to the recovery unit where constant monitoring and recovery is carried out. Intravenous access is maintained open until the child has made a full recovery.

Recovery and discharge

Once the child is in the recovery area and becomes more responsive, one of the parents is allowed to comfort the child. Recovery of most patients is approximately two hours and must comply with current guidelines before a patient can be discharged. They must be fully conscious and alert before discharge is considered. All children are offered jelly or an ice-

block in order to assess recovery and to encourage oral intake. Once the patient has made a full recovery, the cannula may be removed. Parent and child are then allowed to spend some time in a special parent/recovery area where children can watch TV and settle further. Nursing staff need to be satisfied with the child's progress before sending the child home. If there are any concerns the anaesthetist may at this time evaluate the child and decide on the child's readiness to be discharged.

All children undergoing GA are given a postoperative review appointment a week later. This is done to assess the work carried out and to assess the parents response to this modality of treatment. Furthermore, those children that presented with high levels of caries could be monitored more closely and kept in a recall system. However, due to the high demand and increasing waiting lists, this situation is currently under review due to resourcing constraints.

CHAPTER 2 . AIMS & OBJECTIVES

Background to the study

Providing dental treatment under general anaesthesia (GA) is costly in terms of staffing, equipment, time, morbidity and emotional stress. The provision of dental treatment under GA is a service that is often under threat when financial constraints take effect and pressure is often exerted to reduce its use. However the nature and amount of dental disease, much of which is preventable, makes the use of GA necessary. By identifying risk factors associated with its use, recommendations concerning appropriate targeting of dental education and resources can be made. At present little is known about this service in Australia, who access it and for what reasons, and finally what type of treatment is provided.

In New South Wales, Westmead Dental Clinical School is the main provider of specialist dental services and the only hospital that has access to regular paediatric dental general anaesthetic sessions. Therefore this center may be considered to be the largest provider of paediatric dental GAs. A review of the patterns of care and the characteristics of the patients managed at this center since its inception in the early 1980's can provide the basis for future resource planning.

Hypothesis

It can be hypothesised that despite a decline in the prevalence of dental caries in the child population in NSW (and Australia), there has been an increase in demand for paediatric dental GA services. There have been changes to the characteristics of the population involved and the treatment needs of these patients. It has been suggested that more pre-school children from specific socio-economic groups are accessing the service now than in

1984. In addition it is likely that more complex restorative and surgical treatment is now provided as the service has expanded.

Aims

1. To assess the demand for dental general anaesthesia at the Westmead Dental Clinical School, Sydney, Australia.
2. To evaluate the changing pattern of use of GA in children at this hospital over the past ten years.
3. To make recommendations for appropriate future resource planning.

Objectives

1. To evaluate the use of day case anaesthetic services by paediatric dental patients over the past decade.

   Postulate: The number of children receiving dental care under general anaesthesia has increased over the past 13 years.

2. To describe the characteristics of the child patients receiving dental care under GA.

   Postulate: The demographic, socio-economic, and cultural characteristics of these patients have altered over the past 13 years.

3. To identify risk factors associated with children requiring dental care under GA.

   Postulate: That young children from specific ethnic backgrounds make up an increasing proportion of patients requiring extensive dental treatment under GA.

4. To evaluate the changes in the pattern of dental care provided under GA.

   Postulate: The treatment need of the children receiving dental care under GA over the past 12 years has changed with increasingly complex restorative work being required.

5. To monitor the waiting list time for children using this service.

   Postulate: That the demand for dental GA has been met by the service commitment as assessed in terms of the length of the waiting list.

CHAPTER 3 . MATERIAL AND METHODS

A retrospective study of the use of general anaesthesia in children was carried out at the Westmead Dental Clinical School (WDCS), Westmead Hospital, Sydney, Australia. WDCS has provided general anaesthesia for this purpose since 1983, but its use in children has not been evaluated during this time. This study included only cases treated as day-stay admissions, and no attempt was made to record cases treated as overnight admissions (inpatients or emergencies).

Ethical approval was sought from the Western Sydney Health Authority in order to obtain information from patient's records. Data from the central hospital admissions database (PMIATS: Patient Master Index, Admissions Transfer Separation) was downloaded and converted to ASCII text format. Printouts of all GA cases since 1983 to date were obtained.

The following fields were included in these printouts:

- Dental Record Number (DRN)
- Admission date
- Separation date (discharge date)
- Sex
- Date of birth
- Address

Methods

The total number of GA procedures carried out for each year was recorded since 1983. This was done in order to correlate the number of general anaesthetics with the number of sessions and operators available for each calendar year. Therefore, data was also collected regarding the number of sessions per week and the number of operators for each year. A

"session" is defined as four working hours or half a day (morning or afternoon session). The operators involved were all paediatric dentists, either registered specialists or postgraduates undergoing training.

Information from years 1984 and 1996 was recorded. The reason for this decision was that 1984 was the first year in which GA was provided on a regular basis, whilst 1996 provided information of current utilisation of GA services. In this way comparisons and conclusions could be drawn in order to assess changes during the two periods. The computer printouts were carefully screened for the two years selected, noting that some records appeared twice in the lists provided. The reason for this computer error could not be established. After this initial data was cleaned, a request for the patient's notes was made.

On discussion with the hospital statistician a sample size of 209 (all records available) in 1984 and 213 in 1996 were chosen. By using the inbuilt Statistical Analysis System (SAS), a random subset of patient records was selected for the year 1996. In this way a computer printout was obtained with a random selection of the dental record numbers of the chosen files for the year 1996.

Notes for the year 1984 were more difficult to obtain, as many of these patients had not attended this hospital for some years. The bulk of these records were collected from secondary storage rooms, as they were not currently in use. Dental Records department at WDCS coordinated this task. Thirteen records could not be found or had been destroyed. All records retrieved for this year were:

- admissions under Dr Richard Widmer (the only paediatric dentist at the time with admission rights)
- day-stay cases
- patients assessed in the Department of Paediatric Dentistry
- children between the ages of 0 to 16 years of age

The aim of the study was to evaluate the use of services in the department of Paediatric Dentistry, therefore children seen in the Oral-Maxillofacial Unit and treated under GA were not included in this study. Two records of patients older than 16 years of age were found, but not included in this study. Records for the year 1996 were readily available, but had to be retrieved in smaller groups as they were currently in use by other clinicians.

In total, 189 records were used for the year 1984 and 213 for 1996. One person recorded all information. A personal computer with Windows® 95 and Microsoft® Access Database was used for this purpose. A special input sheet was designed (see Appendix No. 7) to expedite data entry and suit individual needs. The information recorded was subdivided into four major groups and details of this data are shown in Table 3.1.

Patient details	**Demographic data**	**Treatment provided**	**Other data**
Gender	Suburb of residence	Extractions	Medical condition
DRN	Assess./Treatment date	Primary dentition	Follow up history
Date of birth	Reason of referral	Secondary dentition	Repeat GAs
Ethnicity	Source of referral	Surgical procedures	Morbidity of GA
Health insurance	Waiting time		Comments

Table 3.1: Data collected for assessment and evaluation of GA use in dentistry for children

Patient details

Gender

The gender of all patients was recorded in the database sheet, and these children were classified as male or female. A sex ratio would then be calculated to work out the proportion of males to females. This information was gathered in order to make comparisons within our patient population and other studies in the literature.

Dental Record Number (DRN)

The DRN was the most useful way of identifying a particular record and maintaining confidentiality for individual patients. It also provided a way of sorting data, and the quickest way of finding a specific set of patient records.

Age

Age was considered an important factor when discussing dental caries and the use of GA in children. This parameter was recorded as date of birth, and age in years at the time of treatment, that is exact age at the GA procedure.

Ethnicity

Ethnicity was recorded with the idea of identifying any ethnic groups that may be more at risk of requiring treatment under GA. However reliable assessment of ethnicity was difficult as patient notes did not always document this accurately. Factors such as country of birth and language spoken at home were taken into account when assigning ethnicity. Due to the multicultural nature of the Sydney population, this parameter was considered of significant importance. Ethnicity was divided into:

- Anglo-Saxon
- Asian

- Middle-Eastern
- Aboriginals
- Other

It is believed that these subgroups made the most relevant ethnic groups when considering GA in children at this hospital. This is based on demographic data from the Australian Bureau of Statistics (ABS), as no previous studies of this nature have been performed at Westmead Hospital.

Health insurance

Health insurance was recorded, as it is important to determine the proportion of patients treated through Medicare (public health system) as opposed to those with private insurance. The provision of a regular private GA list became available only in the last two years (1997 and 1998) and therefore did not affect results of this investigation. However, determining the number of patients with private cover allows us to estimate the proportion of these patients and therefore be able to make recommendations.

Demographic data

Suburb of residence

The place of residence was recorded for all patients. Westmead Hospital has provided dental GA services for children from most areas of Sydney and some other NSW cities in the last decade. The postcode of each patient was recorded and then patient distribution by area was noted for the years 1984 and 1996. These were divided into health areas as specified by the NSW Department of Health:

- Central Sydney
- Northern Sydney

- Southeastern Sydney
- Southwestern Sydney
- Wentworth
- Western Sydney (Westmead Hospital is located in this area)
- Other

Assessment and treatment dates

The assessment date refers to the day when the initial consultation was carried out. These were patients either referred from within the hospital, from another source outside the hospital (private or public) or an emergency/self referred patient. The treatment date refers to the actual day when the general anaesthetic is carried out. All cases included in this study were day-stay procedures. Patients are placed in either a morning or afternoon list, with admission times to the hospital at either 7 am or 11 am respectively.

Reason for referral

The reason for referral is one of the main aspects under investigation in this study. Patients were classified as caries, trauma, dental anomaly, or other. It was felt that these were the main referral reasons for treating child patients under general anaesthesia. It is important to determine why children require these services, and to also compare findings with similar studies in the literature.

Source of referral

The referral source indicates how a particular child patient requiring general anaesthesia came into the department of Paediatric Dentistry. Several sources of referral were noted, and these were classified as:

- General dentists
- Specialist dentists

- School dental service
- Doctors
- Self/emergency patients
- Other

General and specialist dentists included those practitioners in the private sector that have referred patients to this hospital. These dentists usually send a referral letter explaining a particular concern or inability to carry out treatment for whatever reason. The School Dental Service (including both therapists and dentists) refers patients in several ways. Patients are referred either from well established School Dental Service institutions around NSW, or through visits to school grounds to assess children's dental status. The recently introduced program "Save our Kids Smiles" or "SOKS" which started in early 1996, has broadened the number of children assessed per year, and has also affected the referral pattern to this hospital. Medical staff, either general practitioners or specialists refer patients to the hospital from either the private or public sector. This is also considered a proper referral channel as all patients bring a referral letter when first assessed.

Self-referred patients included patients seeking dental care on their own accord, but not necessarily in pain or discomfort. Emergency patients refer to those seeking relief of pain, treatment for trauma and/or odontogenic infections. These particular patients have not sought dental treatment anywhere else, and they present to the hospital as their first place of choice. Westmead Hospital is considered to be a specialist referral centre not a primary healthcare provider and many people are thought to access its services inappropriately. Patients categorised as "Other" included patients referred to the unit by other clinicians within the hospital, as well as patients currently treated within the Paediatric Dentistry unit that after having some treatment initially, were found to be unmanageable.

Waiting time

The waiting time refers to the time period between the assessment date and the treatment date, that is the time of the general anaesthetic procedure. This is a useful parameter when assessing demand of services, as it gives an indication of how long patients wait before they receive treatment under general anaesthesia. It also allows a comparison in demand for services with other institutions that provide similar services. Waiting times were recorded in "days" and an average waiting period was calculated for the years 1984 and 1996.

Treatment provided

Extractions

The number of extractions in the primary and secondary dentitions was recorded in order to compare both periods examined. The database recorded the number of extractions carried out per patient in each dentition. No attempt was made to record the actual teeth (tooth number) being extracted. This figure gives an indication of severity of disease and facilitates comparison with other studies when referring to this treatment modality.

Primary and Secondary dentition

Treatment was recorded for the primary and permanent dentition. The access database form made provision for recording the type and number of restorations (e.g. amalgam, composite resin, glass ionomer, preventive resin restoration, fissure sealants, stainless-steel crowns), the number of extracted teeth, need for pulp therapy or endodontic treatment, and other details. A ratio of the number of treated, extracted, and restored teeth per child in both dentitions was made. This was considered useful as comparisons could be made with the general treatment needs (dmft/DMFT) of the child population in Australia overall, and the treatment needs of children requiring GA at this hospital.

Surgical procedures

The surgical procedures carried out in the department of paediatric dentistry involved mainly minor oral surgery. The most commonly performed procedures involved removal of supernumerary teeth and odontomes, removal of impacted teeth, exposure +/- bonding of unerupted permanent teeth, dento-alveolar trauma, minor soft tissue surgery (tongue tie release, biopsy procedures, mucoceles). Cases involving complicated facial and mandibular fractures, osteotomies, and more invasive surgical procedures are referred to the department of Oral and Maxillofacial Surgery (OMFS) within Westmead Hospital.

Other data

Medical condition

The medical status of patients was recorded in order to compare this study with others. A basic subdivision was made, and patients were classified as:

- None
- Medical

The percentage of medically compromised patients was recorded for the two years selected. This group of patients included any medical condition (mild to severe) and patients that were physically or intellectually handicapped. It was not in our scope to analyse individual medical conditions, however comments were made in regards to the most common medical problems found in children undergoing general anaesthesia.

Follow up history

All patients undergoing a GA were provided with a follow up appointment a week later. This is done to assess that all work performed is satisfactory and review the overall level of satisfaction by parents and patients. However, not all patients comply with post-operative

37% review visits, and three categories were made to assess the number of patients attending these appointments: no follow up, single review or routine checks.

Two groups of patients were considered important in terms of further investigation: first, patients presenting to the hospital with no referrals or as emergency patients; and second, patients that did not present for follow up after their GA. The first group is important as these patients have not accessed dental care through conventional or preferred channels; therefore, their numbers vary constantly and their levels of dental disease may be high. The second group may have individual characteristics that could predispose these children to undergo GA more often. Only 1996 was studied with respect to these two groups. These two groups of patients were divided as: 'self/emergency' patients or 'all others' with respect to referral source, and 'no follow up' and 'attendance' for the follow up patients.

Repeat general anaesthetics

A number of children require more than just one occasion under general anaesthesia to complete dental procedures. These repeat events can be related to medical conditions, behaviour, trauma, or the nature of the procedure itself. It is important to assess this parameter and to see if there are any special characteristics of the children falling in this group. Provision was made to record all subsequent dates for repeat GA procedures in the database sheet.

Morbidity of GA

All complications arising from the general anaesthetic procedure were noted in the data collected. This involved complications such as nausea, vomiting, pain, bleeding (prolonged), respiratory difficulties, and need for overnight admission.

Comments

Any other information considered relevant but not included in any of the previous headings was recorded in this section. These were mainly comments considered relevant at the time of data input. Information such as details of the reason for subsequent GA procedures, parent comments, or long term difficulties arising from dental treatment (medico-legal or clinical).

Statistical analysis

All data was statistically analysed with the help of a research officer from The University of Sydney, Faculty of Dentistry. The data obtained from the Microsoft® Access Database was cleaned and checked for operator induced errors. Then this data was copied to a Microsoft® Excel document for ease of handling due to preference by the author. Copies were made and finally analysed using the program SPSS for Windows.

All data was analysed by using Chi-square test and t-tests. Chi-square tests involved the use of Fisher Exact test and Pearson's test. Student's t-tests were used for comparison of means such as age and waiting time. Tables containing insufficient number of cases/data (less than 5 occurrences) were either collapsed or not statistically tested. The results were considered significant at $p < 0.05$ (the acceptable probability level).

CHAPTER 4 . RESULTS

The demand for GA has increased steadily over the last 13 years. At first sessions were provided on demand, but since 1984 regular sessions were organised. As demand increased, so did the number of hours and the number of personnel involved. A summary of this change is shown in table 4.1. Up until 1990 the number of patients treated reflected the number of operating theatre sessions available at the time. However from 1990 onwards, the number of operating sessions remained stable (4 per week) but the total number of children receiving treatment continued to increase (595 in 1990 to 777 in 1996).

Year	No. patients	No. operators	No. theatre sessions
1983	105	1	on demand
1984	209	2	2
1985	334	3	2
1986	271	3	2
1987	398	3	3
1988	543	3	3
1989	535	3	3
1990	595	4	4
1991	679	4	4
1992	733	4	4
1993	691	4	4
1994	728	4	4
1995	740	5	4
1996	777	6	4

Table 4.1: Total number of patients, operators and sessions per year.

Patient details

The results stated from here onwards were obtained using the 189 patient records found for the year 1984, and the random sample of 213 records for the year 1996.

Gender

Using the Fisher's Exact Test, no significant difference was found between the male:female ratio in the two years (p=0.52). A summary of these results is shown in Table 4.2.

	1984	1996
Male	106	120
Female	83	93
Total no. patients	189	213
Ratio m:f	1.28	1.29
Chi-Square	2.799	3.423
p value	0.094	0.064

Table 4.2: Gender by year group: number of patients, ratio of male to female, and statistical values per year.

Age

Figure 4.1 shows the distribution of age for all children. The most significant finding was that approximately two thirds of patients in both years were 6 years of age or younger. The increase in the number of patients in the 4-6 age group in 1996 was the only statistically significant difference.

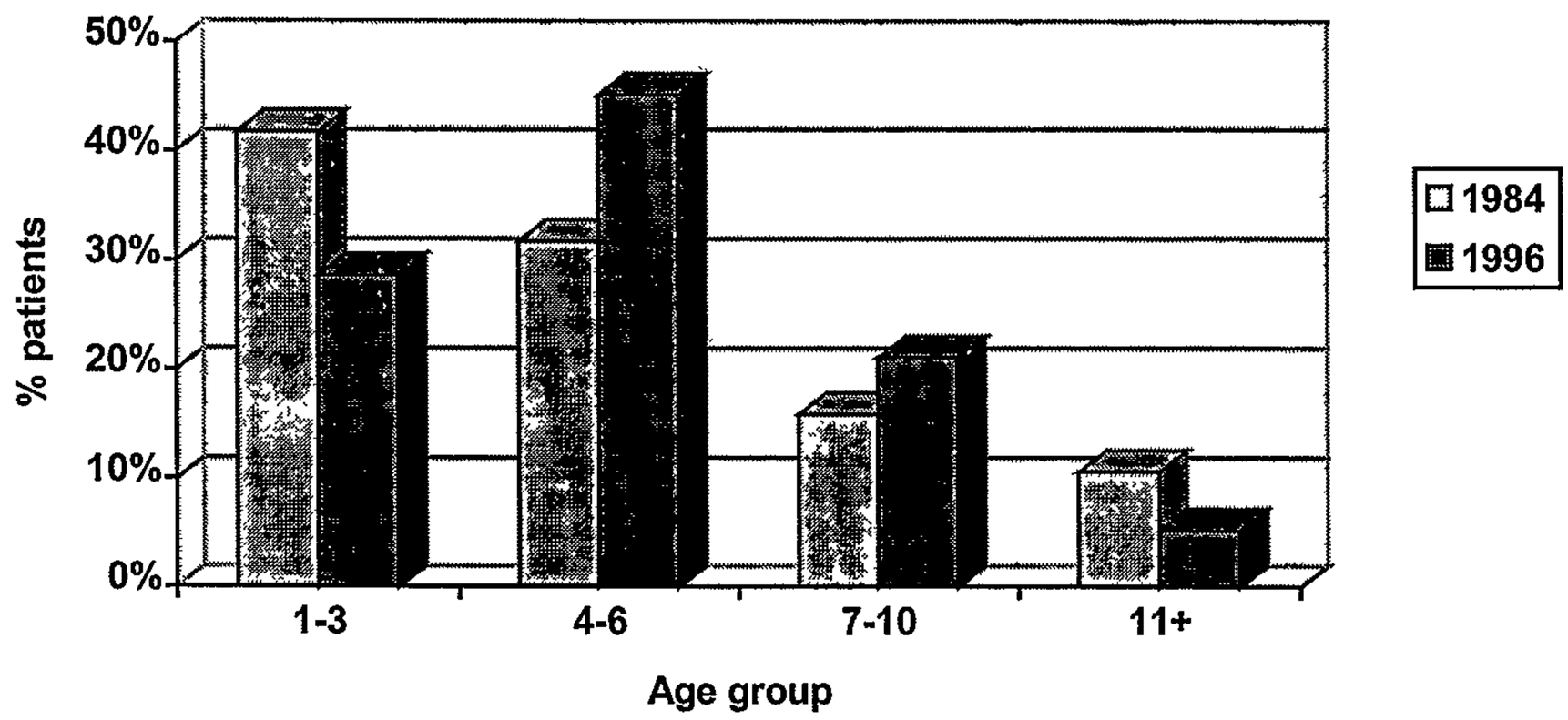

Figure 4.1: Age distribution expressed as percentage of patients for years 1984 and 1996.

Table 4.3 shows the number of patients in each age group, as well as the overall percentage for the two years examined. Statistical analysis was carried out to compare years 1984 and 1996. Significance was tested at a p value of 0.05 or less. In statistical terms, children aged 4-6 years showed the only significant increase at a level of $p<0.05$, however the increase in 7-10 year olds was close to statistical significance ($p=0.066$).

Patients by Age-group	**1984**		**1996**		**Statistical Analysis**	
	No. pts.	**% pts.**	**No. pts.**	**% pts.**	**Chi^2 value**	**p value**
1-3 yrs	75	39.7	59	27.7	1.9104	0.1669
4-6 yrs	64	33.8	97	45.5	6.7640	**0.0093**
7-10 yrs	30	15.9	46	21.6	3.3684	0.0665
11+ yrs	20	10.6	11	5.2	2.6129	0.1060
Total	189	100	213	100		

Table 4.3: Age groups for 1984 & 1996 and statistical values.

Table 4.4 shows the mean ages for years 1984 and 1996. There was no significant difference between the two years examined.

Year	**No. cases**	**Mean**	**SD[1]**	**SE[2] of mean**
1984	189	5.3915	4.141	0.301
1996	213	5.2488	2.626	0.180

Table 4.4: T-tests for independent samples of year-group to determine mean age.

[1] SD: Standard deviation
[2] SE: Standard error

Ethnicity

Ethnicity was assigned to patients according to data from the Australian Bureau of Statistics (ABS). Using this information as a guide, all patients were classified into five major groups. Assigning ethnicity was difficult to achieve and other data such as country of birth, time living in Australia, language spoken at home, and citizenship were considered when available. Table 4.5 summarises the findings for both year groups.

Ethnicity	1984		1996	
	No. patients	% patients	No. patients	% patients
Anglo-Saxon	136	72.0	143	67.1
Asian	12	6.3	21	9.9
Middle-Eastern	12	6.3	29	13.6
Aboriginal	0	0	3	1.4
Other	29	15.3	17	8.0
Total	189	100	213	100

Table 4.5: Ethnicity of child patients for years 1984 & 1996.

This last table shows a clear predominance of Anglo-Saxon patients. Statistical analysis of individual ethnic groups was not carried out, but Chi-Square testing (Pearson's Test) between the two years approached significance (p=0.0605). In other words, differences between the two year-groups as a whole was only tested, but not individual comparisons for any one ethnic group. The reason for this was that several groups had few patients included and interpretation of such data becomes meaningless. Although the Aboriginal patients were too few to assess properly, the changes seen in the Asian and Middle-Eastern groups may be clinically important.

Health Insurance

Children were assessed with regards to their health insurance status and classified as either public or private patients. Public patients included those eligible to be treated through the public health system (Medicare); and private patients those that had private insurance. The results for both years were statistically significant (Table 4.6).

Health Insurance	1984		1996		Statistical analysis	
	No. pts.	% pts.	No. pts.	% pts.	Chi-Square	p value
Public health patients	133	70.37%	211	99.06%	17.6860	0.0000
Private insurance holders	56	29.63%	2	0.94%	50.2759	0.0000
Total	189	100.0%	213	100.0%		

Table 4.6: Number of patients according to health insurance status for years 1984 & 1996.

Demographic data

Suburb of Residence

All patients were divided according to Health Areas (as described by the NSW Department of Health) in order to determine where these patients live. Westmead Hospital is located in the Western Sydney Area and it is the major provider of GA services for children in NSW. The results are presented in Figures 4.2 and 4.3. Statistical analysis was not carried out on the individual groups examined.

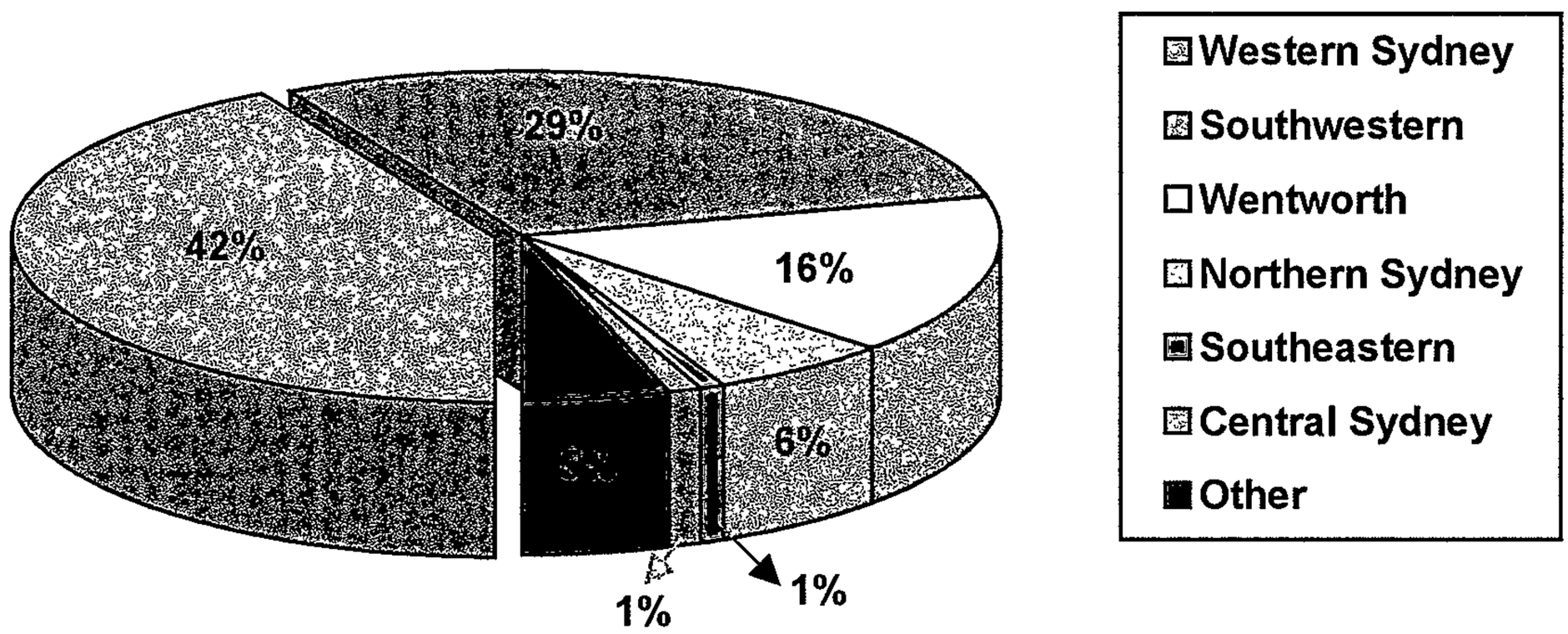

Figure 4.2: Patient's suburb of residence by health area in 1984

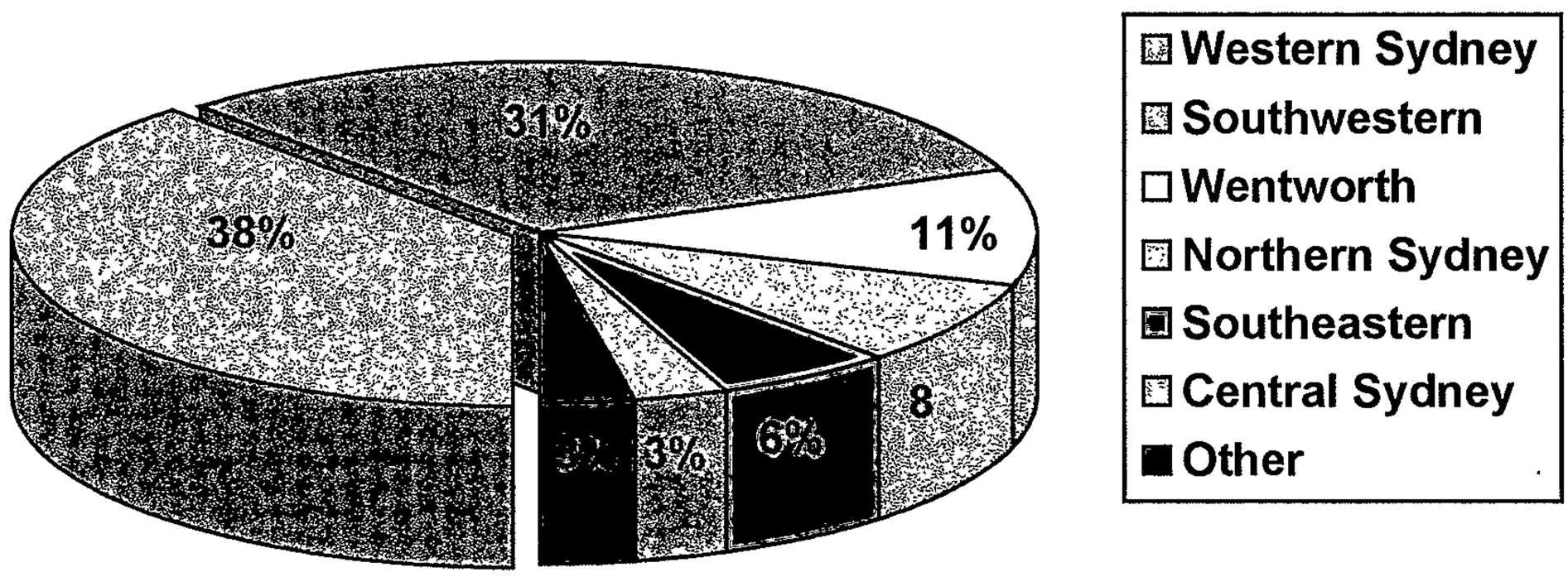

Figure 4.3: Patient's suburb of residence by health area in 1996.

The Western Sydney area was the largest area followed by the Southwestern Health Area. The Southeastern Area increased more than any of the other Health Areas, with some increase also noted for Central Sydney, whereas the Wentworth Area decreased from 1984 to 1996.

Reason for Referral

Reasons for referral were subdivided into four main groups. Dental caries was by far the most common referral reason for GA in children. Results can be seen in Figure 4.4.

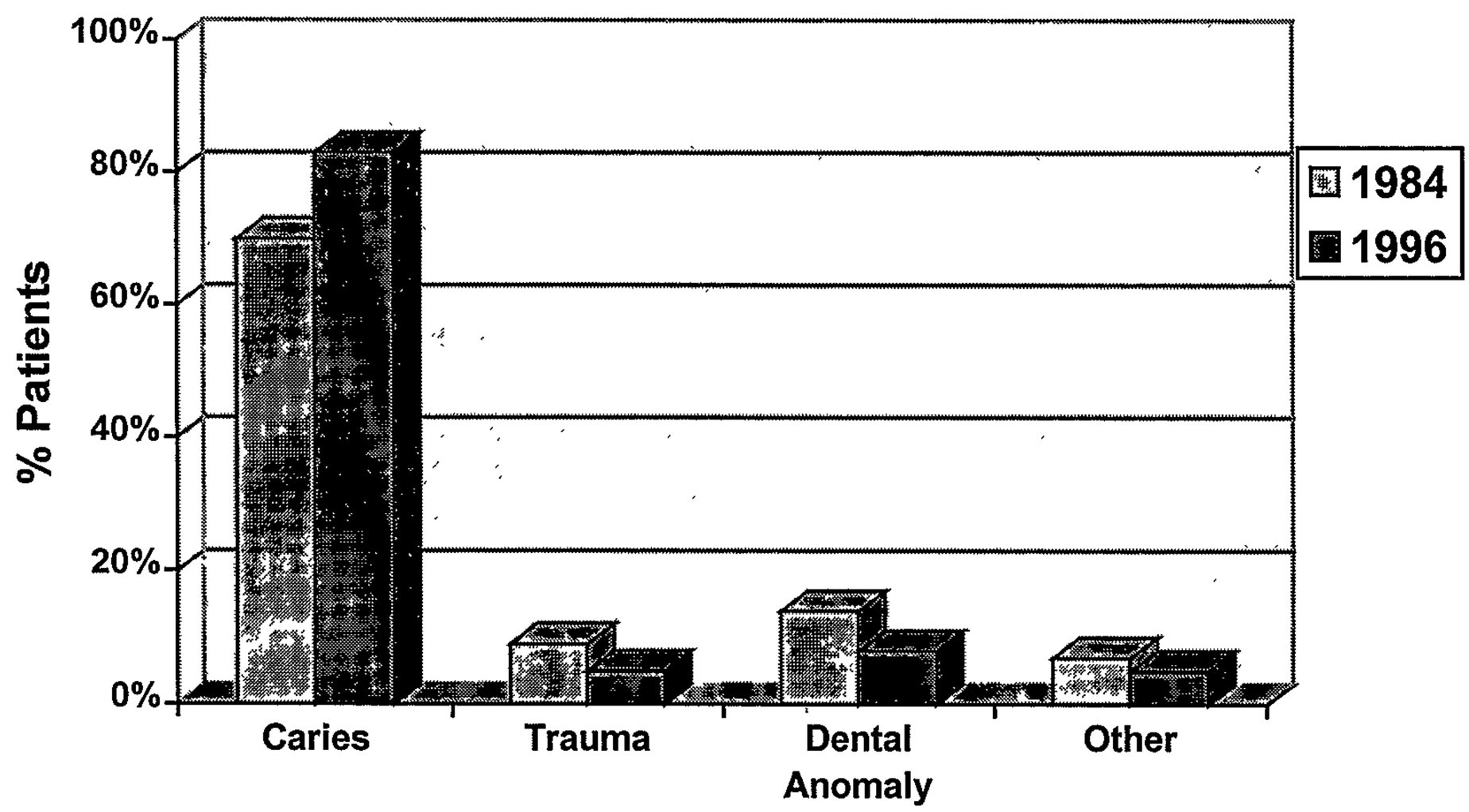

Figure 4.4: Referral reason per year-group

Statistical analysis was carried out using a Chi-Square test (Pearson's Test) at a significance level of $p<0.05$. The increase in the number of children referred with caries was highly significant, with an increase from 70% to 83%. These results are shown in Table 4.7.

Referral Reason	1984		1996		Statistical analysis	
	No. pts.	% pts.	No. pts.	% pts.	Chi-Square	p value
Caries	132	69.8	176	82.6	6.2857	**0.0122**
Trauma	17	9.0	10	4.7	1.8148	0.1779
Dental Anomaly	27	14.3	17	8.0	2.2727	0.1317
Other	13	6.9	10	4.7	0.3913	0.5316
Total No. pts	189	100	213	100	9.3651	0.0248

Table 4.7: Statistical results for referral reason groups for 1984 & 1996.

Cross reference tables were made up by age and reason for referral. This was tabulated in order to determine any trends between these two variables. No statistical analysis was carried out as the numbers in most categories were too small to interpret; caries was the predominant reason for GA referral. Dental anomalies made an important proportion of patients in the 7-10 year old group. These results are shown in Tables 4.8 and 4.9.

1984	Caries	Trauma	D. Anomaly	Other	Row total
1-3 years	58	13	1	3	75 (39.7%)
4-6 years	54	1	5	4	64 (33.8%)
7-10 years	10	2	16	2	30 (15.9%)
11+ years	10	1	5	4	20 (10.6%)
Column Total	132 69.8%	17 9.0%	27 14.3%	13 6.9%	189 100%

Table 4.8: Age group by referral reason for year 1984.

1996	Caries	Trauma	D. Anomaly	Other	Row total
1-3 years	50	7	0	2	59 (27.7%)
4-6 years	92	0	1	4	97 (45.5%)
7-10 years	29	2	13	2	46 (21.6%)
11+ years	5	1	3	2	11 (5.2%)
Column Total	176 82.6%	10 4.7%	17 8.0%	10 4.7%	213 100%

Table 4.9: Age group by referral reason for year 1996.

Source of Referral

Patients access general anaesthetic services in a number of ways. Some come from established referral sources whilst others are self-referred, such as patients seen through the emergency department. Therefore several referral source subgroups were defined and these are shown in figure 4.5.

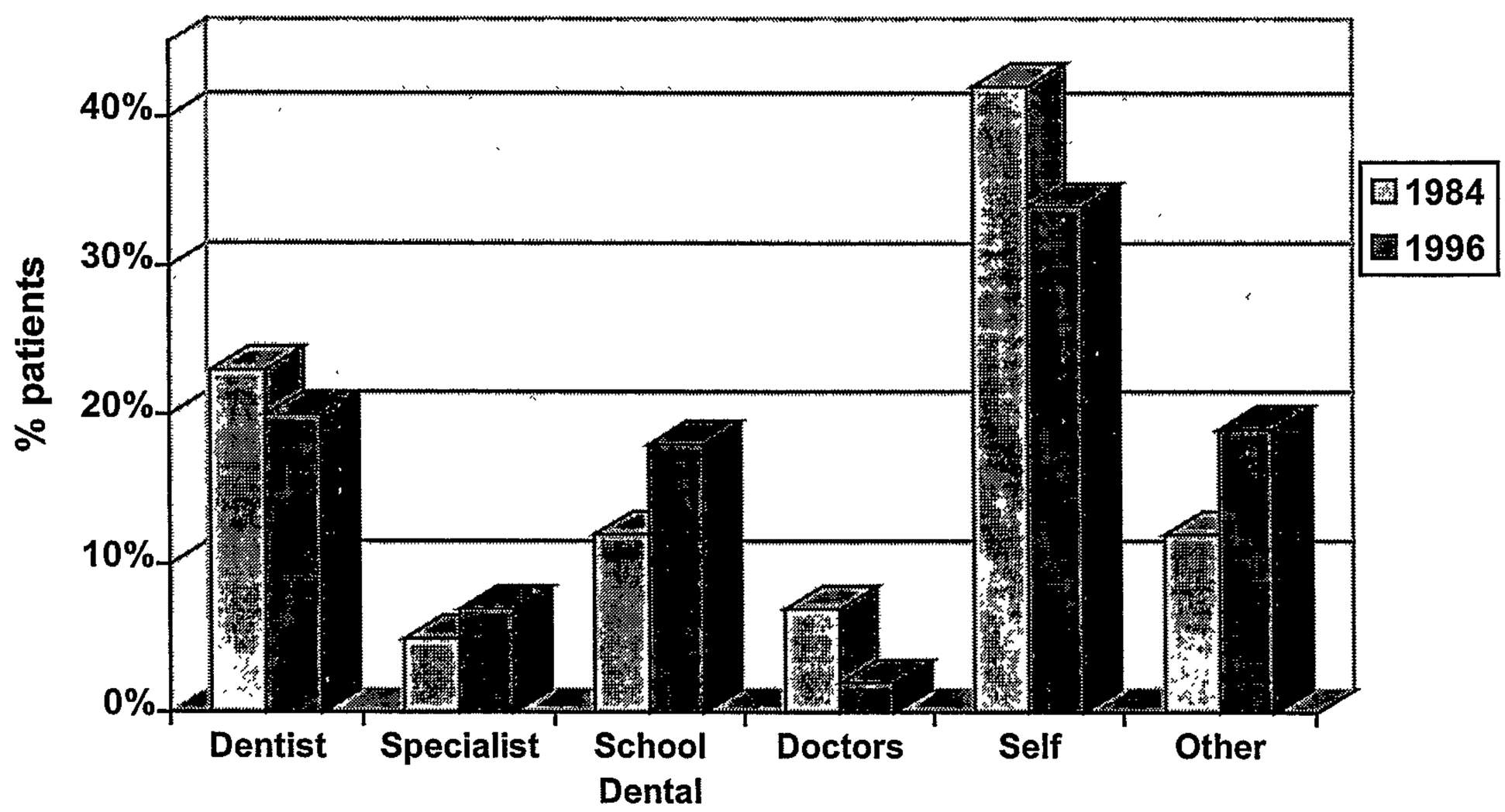

Figure 4.5: Referral source expressed as percentage of patients for years 1984 and 1996.

The number of patients in each referral source group for both years are shown in Table 4.10. Statistical analysis was carried out at a significance of $p<0.05$ using Chi-Square Test. The only statistically significant result was in the group called 'other'. The patients included in this group are patients referred within the Westmead Dental Clinical School by other dentists or therapists. It also included patients that after receiving some treatment in the department of Paediatric Dentistry where considered to be better managed under GA. The increase in the number of patients referred by the School Dental Service approached significance, a finding that deserves further attention.

Referral Source	**Cases Observed**		**Statistical Analysis**	
	1984	**1996**	**Chi-Square**	**p value**
GP Dentist	44 (23.3%)	42 (19.7%)	0.0465	0.8292
Specialist Dentist	9 (4.8%)	14 (6.6%)	1.0870	0.2971
School Dental	23 (12.2%)	38 (17.8%)	3.6885	**0.0548**
Doctors	12 (6.3%)	6 (2.8%)	2.0000	0.1573
Self/Emergency	79 (41.8%)	73 (34.3%)	0.2368	0.6265
Other	22 (11.6%)	40 (18.8%)	5.2258	**0.0223**
Total No. pts.	189	213		

Table 4.10: Referral source groups for years 1984 & 1996 and statistical values.

A comparison was made between source of referral and ethnicity of patients. Certain subpopulations of patients accessed general anaesthetic services through specific channels. The actual figures are shown in Tables 4.11 and 4.12. For the year 1984, it can be seen that 62% of the Anglo-Saxon population accessed the GA hospital service through an established referral channel. Whilst, approximately half of the "Middle-Eastern" and "Other" patients

accessed services through the emergency department, and therefore used the hospital as a primary health care provider. Patients of Aboriginal background were not identified in 1984. For the year 1996, more than half of the Middle-Eastern patients (52%) accessed Westmead GA services through the emergency department. Anglo-Saxon patients (100 out of 143 patients or 70%) continued to access this service from a variety of established referral sources. It was also noted that medical practitioners did not refer as many patients as compared to 1984. No statistical analysis was carried out on this information as the numbers were too small.

1984	Anglo-Saxon	Asian	Middle-East	Other	Total
GP Dentist	31	3	4	6	44 (23.3%)
Spec. Dentist	8	0	0	1	9 (4.8%)
School Dental	17	1	0	5	23 (12.2%)
Doctors	9	0	1	2	12 (6.3%)
Self/Emergency	52	5	7	15	79 (41.8%)
Other	19	3	0	0	22 (11.6%)
Column Total	136 (72%)	12 (6.3%)	12 (6.3%)	29 (15.3%)	189 (100%)

Table 4.11: Referral Source by Ethnicity for year 1984. No "Aboriginal" patients were identified in 1984.

1996	Anglo-Saxon	Asian	Middle-Eastern	Aborigin.	Other	Total
GP Dentist	35	2	1	0	4	42 (19.7%)
Specialist Dentist	10	2	0	0	2	14 (6.6%)
School Dental	22	4	8	1	3	38 (17.8%)
Doctors	4	0	0	0	2	6 (2.8%)
Self/Emergency	43	9	15	1	5	73 (34.3%)
Other	29	4	5	1	1	40 (18.8%)
Column Total	143 (67.1%)	21 (9.9%)	29 (13.6%)	3 (1.4%)	17 (8.0%)	213 (100%)

Table 4.12: Referral Source by Ethnicity for year 1996.

Waiting Time

The waiting time between consultation and treatment under GA was recorded for years 1984 and 1996. These were subdivided into four categories as shown in Figure 4.6. The average waiting time was also recorded and statistically analysed (Table 4.13). It can be seen that the demand for GA has greatly increased in terms of waiting time, as this period has more than doubled in the last 12 years. Comparison by statistical analysis (t-test) of the waiting times proved highly significant (p=0.000). It can be seen from Figure 4.6 that in 1996, over two thirds (67%) of the children had to wait two or more months, and 39% had to wait three months or more to receive treatment.

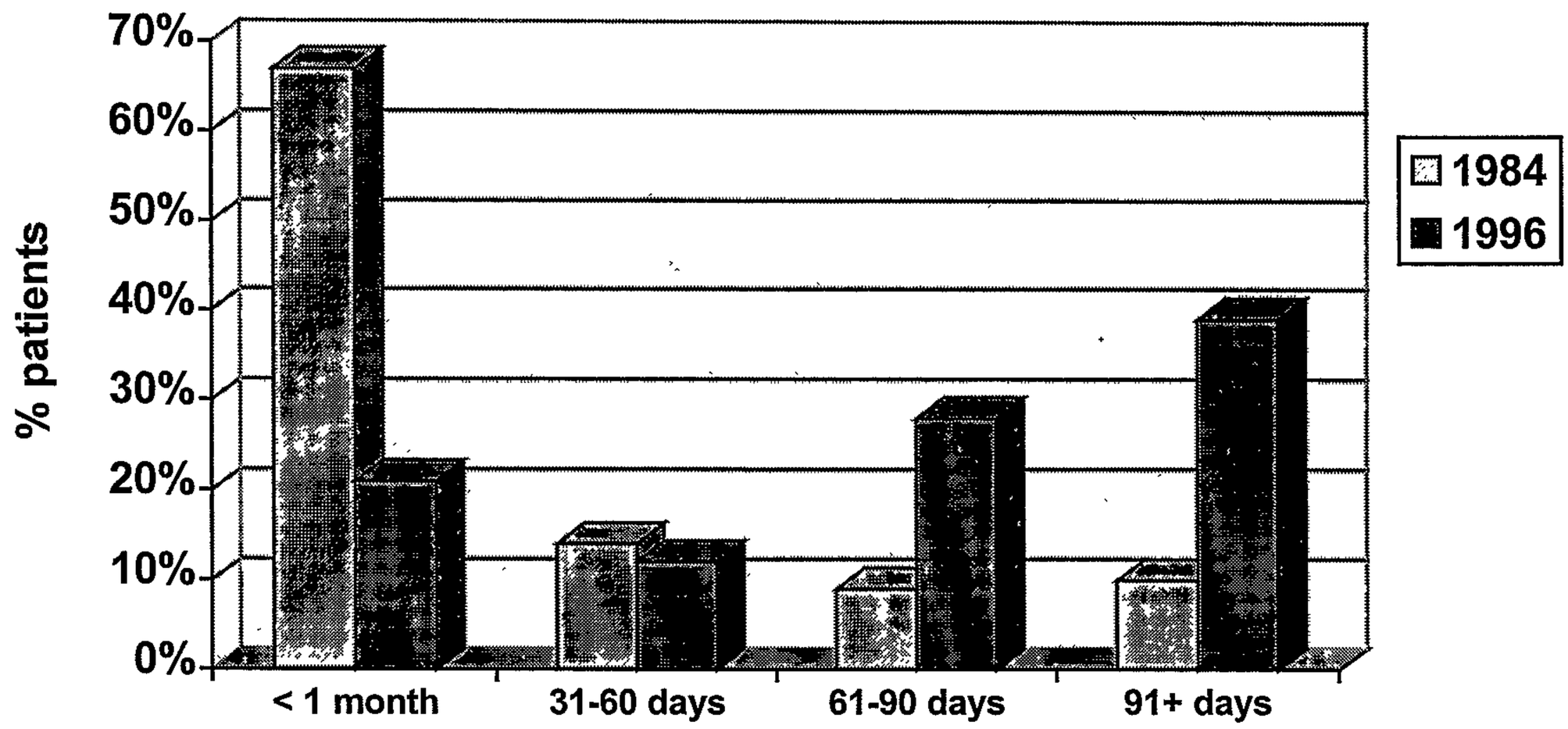

Figure 4.6: Waiting times for years 1984 and 1996.

Waiting time	No. of patients	Mean No. days on waiting list	SE of Mean
1984	189	37.34	4.28
1996	213	81.41	4.07

Table 4.13: Average waiting time in days for years 1984 and 1996.

Treatment provided under GA

Treatment was recorded for both the primary and permanent dentition as well as any surgical procedures performed. The number and type of restorations were recorded for both years and for both dentitions. The number of extractions of teeth was also recorded in both dentitions.

Extractions

Results of the treatment carried out in the primary dentition showed a clear trend towards an increase in the number of extractions in 1984 to 1996 (Table 4.14), this finding being highly significant (p=0.0008). There was a significant increase in the number of patients having one tooth (p=0.0422) or 5-8 teeth (p=0.0003) extracted. Individual trends in numbers of extracted primary teeth can be seen in Figure 4.7. This is illustrated to show that certain subgroups have increased during the period of this study.

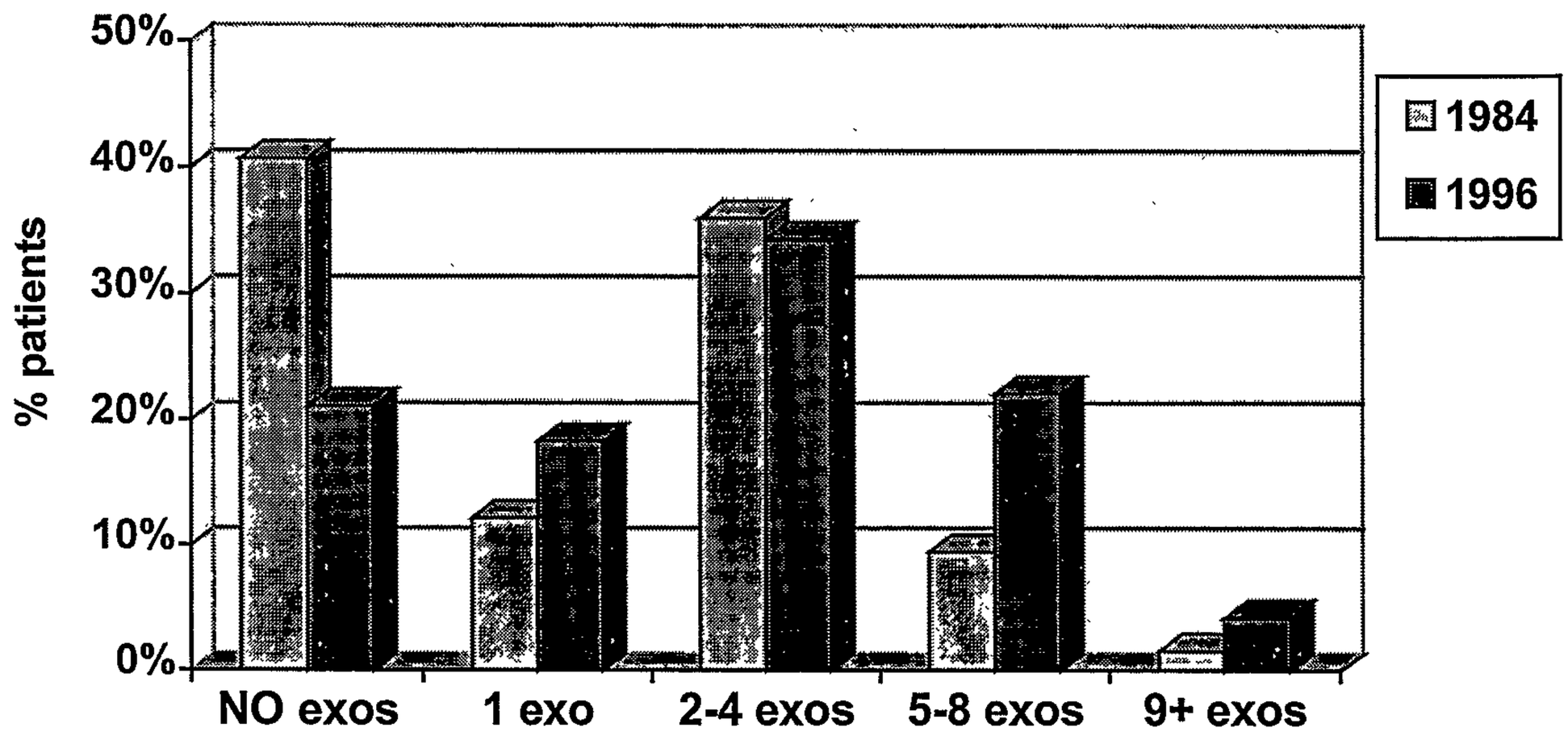

Figure 4.7: Extractions of primary teeth in categories for years 1984 and 1996.

	1984		1996		Statistical Analysis	
	No. pts.	% pts.	No. pts.	% pts.	Chi^2 test	p value
NO exos	77	40.7%	45	21.1%	8.3934	**0.0038**
Extractions	112	59.3%	168	78.9%	11.200	**0.0008**
1 exo	23	20.5%	39	23.2%	4.1290	**0.0422**
2-4 exos	68	60.7%	73	43.5%	0.1773	0.6737
5-8 exos	18	16.1%	47	28.0%	12.9385	**0.0003**
9+ exos	3	2.7%	9	5.3%	3.0000	0.0833

Table 4.14: Statistical analysis of extraction groups in the primary dentition

The number of permanent teeth extracted was small for both years examined. In 1984, 10.6% of patients (37 extractions in 20 children) had one or more extractions. Comparatively in 1996, 5.6% children (18 extractions in 12 patients) had extractions. There was a tendency to extract less permanent teeth in 1996, but this result was not statistically analysed.

Primary Dentition

Restorative trends in the primary dentition changed from 1984 to 1996. The mean number or restorations in the primary dentition decreased from 4.84 in 1984 to 4.05 in 1996. The restoration/extraction ratio for the primary dentition decreased from 2.4 in 1984 to 1.3 in 1996. The most evident result was that no amalgams or stainless steel crowns (SSCs) were recorded in 1984. Glass Ionomer restorations (GIC) were by far the most common material used during this year. It is interesting to note that although the number of glass ionomer restorations nearly halved from 1984 to 1996, the actual number of patients receiving this treatment modality remained virtually unchanged. In contrast, 1996 revealed a wider choice of materials when restoring primary teeth. Although GICs were still popular, materials such as SSCs, amalgam, and composite were used with increased frequency (Table 4.15). The use of stainless steel crowns showed the greatest increase. No statistical analysis was carried out on this data.

Treatment	No. restorations		No. patients receiving this tx.		% patients out of total for year	
	1984	1996	1984	1996	1984	1996
Amalgam	0	39	0	23	0%	10.8%
CR*	16	84	3	36	1.6%	16.9%
GIC*	647	368	112	116	59.3%	54.5%
SSC*	0	152	0	76	0%	35.7%
Pulp Therapy	118	90	57	53	30.2%	24.9%
Other	134	129	45	38	23.8%	17.8%
Total	915	862				

Table 4.15: Treatment provided in the primary dentition in 1984 and 1996. The group "other" refers to fissure sealants, scale and prophylaxis, discing of teeth or any other procedure not included.

***Abbreviations:** Composite Resin Restoration (CR); Glass Ionomer Restoration (GIC); Stainless Steel Crown (SSC)

Permanent Dentition

The results obtained in the permanent dentition were related to the type of restorations and their number. It was not in the scope of this study to make any other analysis. This information was tabulated in Table 4.16. From this table it can be seen that 22% of children had a restoration of some description in 1984 as compared to 25% in 1996.

It is apparent from this data that the number of fissure sealants has greatly increased during the period of this study. Also, amalgam and composite resin restorations were used with increased frequency, whereas the number of glass ionomer restorations in permanent teeth decreased markedly in 1996. Meaningful description of other procedures was not possible as the number of restorations was too small.

Treatment	No. restorations		No. patients receiving procedure.		% patients out of total for year	
	1984	1996	1984	1996	1984	1996
Amalgam	6	22	6	11	3.17%	5.16%
CR*	6	19	3	10	1.59%	4.69%
GIC*	40	10	16	4	8.47%	1.88%
CRFS*	42	87	14	23	7.41%	10.8%
PRR*	0	1	0	1	0%	0.47%
SSC*	0	3	0	1	0%	0.47%
Ant. Aesth.*	0	1	0	1	0%	0.47%
RCT*	2	3	2	2	1.06%	0.94%
Total	96	146	41	53	21.7%	24.88%

Table 4.16: Treatment provided in the permanent dentition for years 1984 and 1996. Percentage figures given for the total number of patients for that particular year.

***Abbreviations:** Composite Resin Restoration (CR); Glass Ionomer Restoration (GIC); Composite Resin Fissure Sealant (CRFS); Preventive Resin Restoration (PRR); Stainless Steel Crown (SSC); Anterior Aesthetic Restoration (Ant. Aesth.); Root Canal Therapy (RCT).

Surgical procedures

A total of 38 (20%) children required surgical intervention in 1984, as compared with 25 (12%) children in 1996. Surgical procedures were recorded into five subgroups: dental anomalies, orthodontic procedures, oral pathology, soft tissue, and medical condition. There was a decline in the number of surgical procedures carried out from 1984 to 1996; no statistical analysis was carried out due to the small number of patients. Dental anomalies were the main reason for surgical intervention in the unit, with removal of supernumeraries being the most frequent procedure. Surgical procedures involving soft tissue (eg. lingual or labial frenectomy) and oral pathology were also common (Table 4.17). Surgical procedures in children carried out in the department of Oral & Maxillofacial Surgery were not included in this study.

Year		**1984**		**1996**	
		No. patients	**% patients**	**No. patients**	**% patients**
SURGICALS	Dental Anomaly	25	13.2%	20	9.3%
	Orthodontic	0	0%	0	0%
	Oral Pathology	3	1.6%	1	0.5%
	Soft Tissue	8	4.2%	4	1.9%
	Medical Reason	2	1.1%	0	0%
	Total Number	**38**	**20.1%**	**25**	**11.7%**
No surgical		151	79.9%	188	88.3%
Total No. patients		189	100%	213	100%

Table 4.17: Surgical procedures carried out in 1984 and 1996.

Other Data

Medical Condition

All patients included in the study were screened for medical conditions. These patients were classified into two groups: 'none' and 'medical'. Table 4.18 shows the results obtained for this variable.

Medical Condition	1984		1996		Statistical analysis	
	No. pts.	% pts.	No. pts.	% pts.	Chi-Square	p value
None	147	77.8	155	72.8	0.2119	0.6453
Medical	42	22.2	58	27.2	2.5600	0.1096
Total	189	100	213	100		0.25076

Table 4.18: Medical condition of child patients undergoing GA for 1984 & 1996.

Statistical analysis found no significant differences for the two years examined (Two-Tail Fisher's Exact Test). Furthermore, no significant differences were found when testing each group individually.

Follow up history

As a routine measure all paediatric patients having a GA are given at least one post-operative review appointment. This is done with the purpose of assessing the work carried out, reinforcing oral hygiene and dietary control and evaluating the overall experience to this treatment modality. Data gathering however showed that not all patients presented to this follow appointment. Therefore patients were assigned into one of three major groups as shown in Figure 4.8.

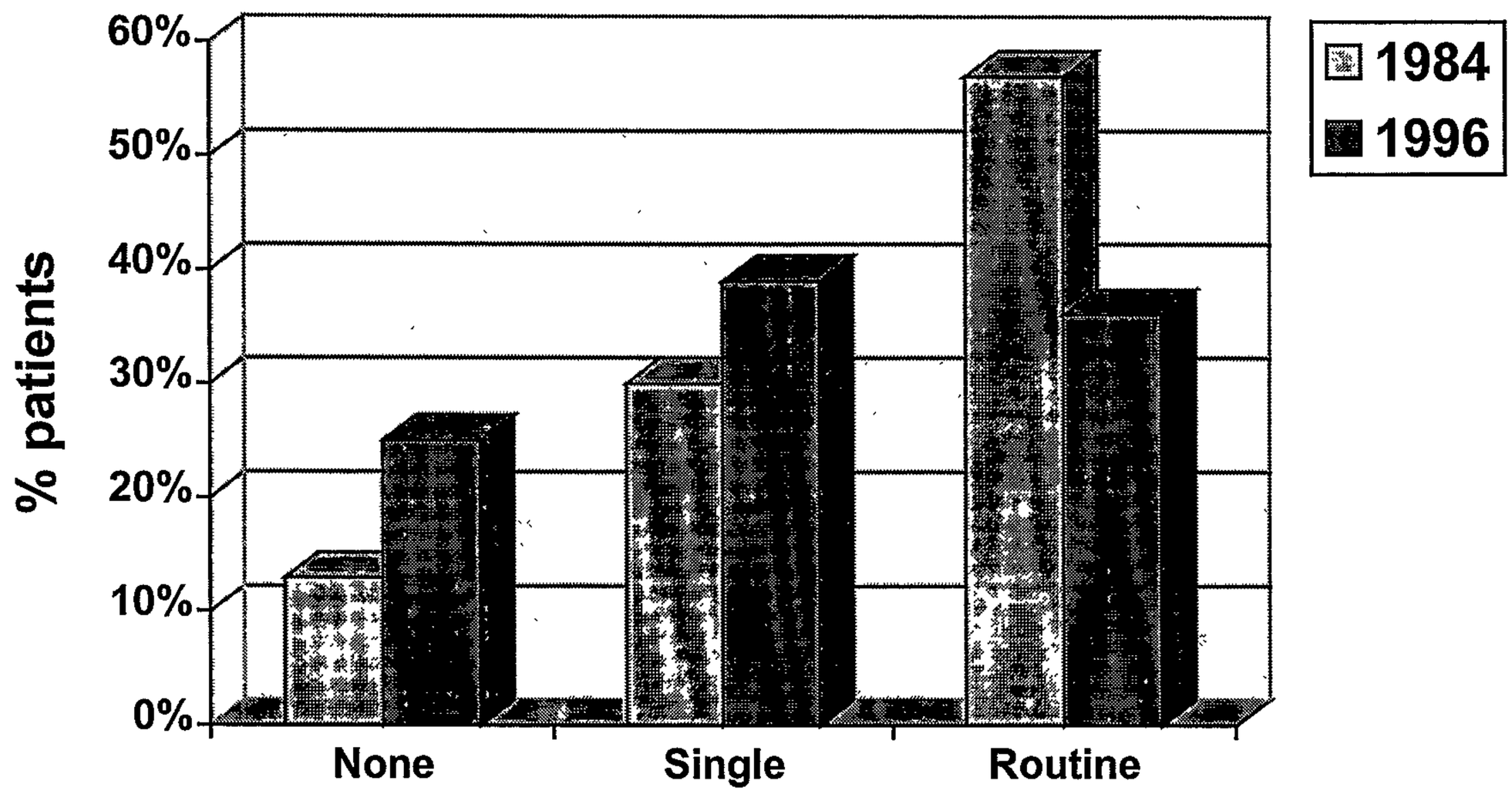

Figure 4.8: Percentage of patients by follow up history in 1984 and 1996.

Evaluation of this data showed that all observed changes in each group were statistically significant. The most striking change was the increase in the number of patients in the "none" group (Table 4.19).

FOLLOW UP	Cases Observed		Statistical analysis	
	1984	1996	Chi-Square	p value
None	25	54	10.6456	**0.0011**
Single	57	83	4.8286	**0.0280**
Routine	107	76	5.2514	**0.0219**
Total	189	213		

Table 4.19: Statistical results of follow up history for patients in 1984 and 1996.

In 1996, two groups of patients were evaluated more closely: self/emergency patients and those patients that failed to attend their post-operative review appointments. Table 4.20 summarises the data with respect to the patient characteristics. No statistical analysis was carried out as some of the numbers were too small to draw meaningful results. In 1996 a total of 73 children (34%) accessed the GA service as a self/emergency attendance, that is using Westmead Hospital as a primary healthcare provider. Out of these, 62 children (85%) were under six years of age which is similar to the overall number of children below this age (83%). Approximately half of the Asian and Middle-Eastern patients (48%) accessed the hospital through the emergency department. The number of Anglo-Saxon patients accessing Westmead Hospital directly was significantly less (43 out of 73 children, or 30%) as compared to the total numbers in the population (143 out of 213, or 67%) for that year.

Fifty-four children (25%) failed to attend any recall appointment in 1996. Of these patients, 42 (78%) were 6 years or younger. This result is slightly higher than the number of children of the same age (73%) for the overall population. The proportion of Anglo-Saxon patients was relatively similar in this group as compared to the overall ethnicity for 1996 (63% and 67% respectively). What is not known is whether there is any relation between the two groups, that is the primary healthcare users and the no follow up group.

Categories		Self/emergency patients	No follow up patients	Total No. patients
GENDER	Male	42 (19.7%)	23 (10.8%)	120 (56.3%)
	Female	31 (14.6%)	31 (14.6%)	93 (43.7%)
	Total	**73 (34.3%)**	**54 (25.4%)**	**213 (100%)**
AGE-GRP	1-3 years	21 (9.9%)	18 (8.5%)	59 (27.7%)
	4-6 years	41 (19.2%)	24 (11.3%)	97 (45.5%)
	7-10 years	10 (4.7%)	9 (4.2%)	46 (21.6%)
	11+ years	1 (0.5%)	3 (1.4%)	11 (5.2%)
	Total	**73 (34.3%)**	**54 (25.4%)**	**213 (100%)**
ETHNICITY	Anglo-Saxon	43 (20.2%)	34 (16.0%)	143 (67.1%)
	Asian	9 (4.2%)	5 (2.3%)	21 (9.9%)
	Middle-East	15 (7.1%)	7 (3.3%)	29 (13.6%)
	Aboriginal	1 (0.5%)	2 (1.0%)	3 (1.4%)
	Other	5 (2.3%)	6 (2.8%)	17 (8.0%)
	Total	**73 (34.3%)**	**54 (25.4%)**	**213 (100%)**
MEDICAL	None	57 (26.8%)	43 (20.2%)	155 (72.8%)
	Medical	16 (7.5%)	11 (5.2%)	58 (27.2%)
	Total	**73 (34.3%)**	**54 (25.4%)**	**213 (100%)**

Table 4.20: Patient detail characteristics of follow up and referral source groups in 1996. Note that all percentages quoted are out of 213 patients for that year.

Table 4.21 shows that 92% (67 out of 73) of emergency paediatric patients that required a GA did so due to dental caries. This is significantly higher compared to the overall population that required GA due to caries (83%). Furthermore, 46% of children (25 out of 54) that presented as emergency patients in 1996 failed to attend their follow up appointment. This is highly relevant as these patients do not appear to access regular dental care.

Categories		**Self/emergency patients**	**No follow up patients**	**Total No. patients**
REF-REASON	Caries	67 (31.5%)	44 (20.7%)	176 (82.6%)
	Trauma	5 (2.3%)	5 (2.3%)	10 (4.7%)
	Dental Anom.	1 (0.5%)	3 (1.4%)	17 (8.0%)
	Other	0	2 (1.0%)	10 (4.7%)
	Total	**73 (34.3%)**	**54 (25.4%)**	**213 (100%)**
REF-SOURC	Dentist		11 (5.2%)	42 (19.7%)
	Spec. dentist		5 (2.3%)	14 (6.6%)
	School dental		10 (4.7%)	38 (17.8%)
	Doctors		1 (0.5%)	6 (2.8%)
	Self/emerg.	**73 (34.3%)**	25 (11.7%)	73 (34.3%)
	Other		2 (1.0%)	40 (18.8%)
	Total		**54 (25.4%)**	**213 (100%)**

Table 4.21: Demographic data of follow up and referral source groups for year 1996. Note that all percentages quoted are out of 213 patients for the year.

Table 4.22 showed that neither the 'no follow up' nor self/emergency patients were likely to require a surgical procedure under GA. In regards to extractions of primary teeth,

self/emergency patients required one or more extractions in 87% of cases (64 out of 73 children) and the no follow up group in 82% (44 out of 54). Again, this proportion is higher (but not statistically proven) when compared to the overall number of children that required extractions of primary teeth (79%).

Categories		Self/emergency patients	No follow up patients	Total No. patients
SURG	Surgical	2 (0.9%)	4 (1.9%)	25 (11.7%)
	No surgical	70 (32.9%)	50 (23.5%)	187 (87.8%)
	Total	**72 (34.0%)**	**54 (25.5%)**	**212**
1RY-EXOS	No exos	9 (4.2%)	10 (4.7%)	45 (21.1%)
	1 exo	17 (8.0%)	17 (8.0%)	39 (18.3%)
	2-4 exos	25 (11.7%)	16 (7.5%)	73 (34.3%)
	5-8 exos	17 (8.0%)	9 (4.2%)	47 (22.1%)
	9+ exos	5 (2.3%)	2 (0.9%)	9 (4.2%)
	Total	**73 (34.3%)**	**54 (25.4%)**	**213 (100%)**

Table 4.22: Treatment provided for patients of follow up and referral source groups for year 1996.

CHAPTER 5 . DISCUSSION

Despite the decline in caries experience in young people over the last 20 years, there remains groups of children and young people who still have high treatment needs (Blinkhorn and Davies, 1996; Downer, 1994). There is, in addition, a proportion of children and young adults who, because of a disability, are unable to accept routine dental care and for whom, treatment under general anaesthesia may be the only means of providing that dental care (Murray, 1993). The demand for general anaesthesia in paediatric dentistry at Westmead hospital has significantly increased since the opening of this unit in 1983. In general terms it can be seen that since 1983 the number of patients treated increased more than seven-fold (from 105 in 1983 to 777 patients in 1996). A significant development that directly allowed for this increase was the number of theatre sessions available per week. During 1983 GA sessions were provided on demand, but from then on services were restructured and regular sessions were provided. Between 1987 and 1990 the number of sessions increased to two theatres operating all day long. In addition, the number of paediatric dentists and registrars increased from two in 1984 to four in 1996 which allowed for better staffing and rostering and therefore increased efficiency. In 1996, this allowed an average of 16 children to be treated under GA per week. These two changes allowed this unit to directly cope with the increased demand in the number of patients. It is clear that as demand increases, the provision for more staff and more hours will allow a greater number of patients to be seen. However there is a need to assess those factors that explain why demand has increased and to compare our experience to other studies in the literature.

The increase in demand seen in the current study is in line with worldwide trends (Smallridge et al. 1990; Vermeulen et al. 1991; Holt et al. 1992; Thomson, 1994; Mason et al. 1995; Nunn et al. 1995). It is also apparent that the use of GA in Europe, UK, Australia and New Zealand is more common than in the USA, where other forms of sedation are used more frequently (Wright et al. 1991b; Wright et al. 1991a). The reasons for this increase

appear to be different in each study. The nature of the healthcare system, the culture of the country, and other factors within each study may influence demand.

Patient characteristics

Gender

Although the ratio of male to female is recorded in most studies of this type, there is no clear consensus whether any one sex predominates in studies of general anaesthesia in children. Our study is in accordance with this finding as there were no statistically significant differences between male and females for the two years studied. However, a slight predominance of males over females was noted for both periods, a finding consistent with several papers (Bohaty and Spencer, 1992; Harrison and Roberts, 1998; Enger and Mourino, 1985; Holt et al. 1992; Keniry, 1974; Mitchell et al. 1985; Thomson, 1994; Vermeulen et al. 1991; Wong et al. 1997). In contrast, an equal number of studies found the opposite to be true, with more females than males in their populations (Barclay, 1974; Grytten et al. 1989; Holt et al. 1991; McLaughlin et al. 1987; Whitehead, 1971).

Age

The current study suggests that it is the younger age group that have greater need of GA, with approximately two thirds of our patients being six years of age or younger. This finding is in agreement with several other studies (Bohaty and Spencer, 1992; Chippendale and Storey, 1988; Grytten et al. 1989; Holt et al. 1992; Keniry, 1974; Nunn et al. 1995; O'Brien and Suthers, 1983; O'Sullivan and Curzon, 1991; Thomson, 1994; Vermeulen et al. 1991). Median age is commonly referred to in these studies as it provides an easy way to compare age distribution (see Table 1.4, page 62). The Sydney study showed no significant change in the mean age of the patients (5.39 years in 1984 compared to 5.25 in 1996). In other words, most of these children were of preschool age for the two periods examined.

This view is supported by long term studies that show the median age of patients falling significantly over the last two to three decades, to mostly include preschool children (McLaughlin et al. 1987; Nunn et al. 1995; Wong et al. 1997). However one study exclusive to children found an increase in the number of children 10-14 years of age, and suggested that this may be due to more minor oral surgery procedures being now carried out (Mason et al. 1995).

The significant increase of the 4-6 year old group may be related to caries trends in the Australian population, as there is evidence that caries is high in some groups of children (Davies et al. 1997). This particular increase in 4-6 year olds, and the decrease of 1-3 year olds have also been observed in America (Bohaty and Spencer, 1992) and the UK (Nunn et al. 1995). It is possible that these 4-6 year old children had heavily restored dentitions requiring maintenance but were still not prepared to accept routine dental care. Another reason that may have influenced this increase in the 4-6-year-old group are the changes brought about by the SOKS program. This program now screens the dental health of all children in the state of NSW attending public primary schools. This means that greater proportions of children 5-6 years (in Kindergarten) were checked in 1996 as compared to 1984. This screening was intended to increase parental awareness and to increase the number of children seeking dental care. Other factors that may influence the age of children undergoing GA include caries trends of the population (Bohaty and Spencer, 1992; Chippendale and Storey, 1988), availability of GA services (Bohaty and Spencer, 1992), referral patterns (Grytten et al. 1989), medical conditions (Boulanger, 1990; Persliden and Magnusson, 1980), and the amount and type of treatment required (Nunn et al. 1995). The young age of some children and their high caries rate is consistent with caries trends in Australia, where a small proportion of children account for most of the caries seen in the child population (Davies et al. 1997; Widmer and Mekertichian, 1996). Overall, the findings of the Sydney study may not be as surprising as health programs in NSW are well developed for children of school age and the fact that most older children accept dentistry more readily

than their younger counterparts. However, it is apparent that there is a lack of dental health screening in children of preschool age.

Ethnicity

There was little significant change in ethnicity of the population group. The results showed a clear predominance of Anglo-Saxon patients (72% in 1984 and 67% in 1996), a finding consistent with the overall ethnicity of the Sydney population. There was a significant increase in the number of Asian and Middle-Eastern children for the two periods examined (from 12.6% in 1983 to 23.5% in 1996), a finding which is in line with changing Sydney demographics. Similar trends were noted in a USA study where the ethnicity of their population changed over a 12-year period (Bohaty and Spencer, 1992). They found an increase in the Black population (16 to 22%) compared to a significant decrease in the White population (82 to 73%). Asian and Hispanic patients made a smaller group with an increase from 2 to 5%. Although it is clear that ethnicity is very specific to each country, it is worth noting that changes in migrant minority groups are reflected in GA studies of developed countries such as the US and Australia.

A ten-year review of the use of general anaesthesia in paediatric dentistry in the UK reported similar trends on the ethnicity of their patients. Although most of their patients were of Caucasian origin, there was a clear increase in the number of Asian children being treated. This change over time may have reflected local population changes, but also suggested that the non-Caucasian groups (especially the Asian) may have changed their attitude to dentistry. That is, desiring to have comprehensive treatments rather than just extractions when in pain (Wong et al. 1997). The Sydney study also showed changes in the Asian groups, although in our experience these patients continued to have high levels of dental disease, high number of extractions, and a large proportion (approximately 50%) accessed the GA service through the emergency department.

The increase of specific ethnic groups has clinical implications as it suggests that these children have high levels of disease as compared to other children. Furthermore, many of these children and their families may not be long term residents in Sydney and may have language difficulties. This requires the use of interpreter services so appropriate instructions are given and consent is obtained, which further increases the cost to the provider and the time required to deliver such care. It is interesting to note that in one Australian study 35% of their patients were not lifetime residents in the city of interest (Melbourne). Of these, Asian children had significantly more extractions of teeth than children of European and other ethnic origins did (Chippendale and Storey, 1988). Our study did not investigate whether patients were lifetime residents, but supports the finding of the high treatment demands of the Asian children, as well as the Middle-Eastern group of children. Aboriginal children made a small proportion of patients and were only represented in 1996 (1.4%). It is our belief that Aboriginal children were under-represented in the sample chosen, as several centres in Sydney refer aboriginal children to our department, many of whom require GA due to their high caries levels. In comparison, a study from New Zealand suggested that Maori and Pacific Island children might be more represented than their European counterparts in proportion to the overall ethnicity of their population. They also believed that patients from a lower socio-economic status were over-represented in their study (Thomson, 1994).

Two groups were considered for further investigation in our study for the year 1996. These were patients that did not present for follow up and children that presented to our unit through the emergency department without a formal referral. Most children accessing GA through emergency (85%) were below the age of six years. Therefore, it is apparent that these children have no routine dental care and they are of preschool age, so public screening programs (such as SOKS) cannot detect them. 46% of the children that failed to attend their post-operative appointments presented to our hospital through the emergency department. 92% of the children presenting to the emergency department that required GA, did so

because of caries or its effects (compared to 83% of children for the overall population for 1996). Approximately half of the children of Asian/Middle-Eastern background accessed the GA services through the emergency department. This is an important consideration as it is thought that many of these families learn of these services by word of mouth and therefore bypass more traditional channels. It is apparent from these results that patients accessing the GA service with no proper referrals are an important group due to their young age, their high caries levels and the fact that they are not interested in normal follow up procedures.

Demographic data

Suburb of Residence

The subdivision of the Sydney metropolitan area into Health Areas allows evaluation of location of demand for GA services. From the results it is apparent that patients from the Western Sydney and Southwestern Areas comprised the largest group using the service. Westmead Hospital is the major provider of paediatric dental general anaesthesia in NSW as no other centres provide GA services with such regularity. Despite having a small proportion of patients coming from far away distances within this state, there has been no major shift in the patient place of residence. However, the fact that a proportion of patients travel from outside Sydney to seek dental care at Westmead Hospital highlights the difficulties in access to GA services that some areas experience.

There is increasing emphasis in health services administration on accountability to the consumer. Therefore, the acceptability of the service to those using it is a major topic of investigation. It is also apparent that attending for treatment has a cost to the families in terms of both time spent at the hospital and in travelling and the financial cost involved (Holt et al. 1991). Several studies have reported on the significance of travelling times for patients seeking treatment under general anaesthesia (Holt et al. 1991; Grytten et al. 1989;

Holt et al. 1992; Smallridge et al. 1990; Wong et al. 1997). Unlike the Norwegian study (Grytten et al. 1989) in which a gradual shift in the place of residence of their patients was noted between 1975-83, the Sydney study did not show this particular trend as the proportion of patients from different areas remained virtually unchanged. It appears that most patients in our study come from centralised suburbs of the Sydney metropolitan area, a finding consistent with certain ethnic groups that appear to concentrate in specific areas of this city.

Studies from the UK have reported more extensively on travelling times and place of residence for child patients undergoing dental general anaesthesia. A study from a London hospital found that out of their 103 child patients, 40 of the children (39%) travelled more than 10 miles and 60 travelled between 2-10 miles. The total time spent travelling varied between 25 minutes and 6 hours, with a mean of two hours. One or more adults accompanied all children, and a total of 79 adults had to take time off work to attend the hospital. Acceptability of this form of treatment was however high (Holt et al. 1991). A comparative study of three London hospitals showed different patterns in travelling times, but in most cases children resided within a ten-mile radius of the operating centre(Holt et al. 1992). A more recent review article of day-stay cases for children found that 25% of patients travelled more than 10 miles for treatment (Wong et al. 1997). These results are consistent with another UK study that found that 20% of patients lived more than 10 miles from the hospital (Smallridge et al. 1990). The Sydney study did not record distances or travelling times for the patients involved and this would be useful in future studies to allow a more direct comparison of this data. In our case, one or usually two adults accompany all children, and families are encouraged to travel back home by private transport. The present study supports the previous ones (Wong et al. 1997) and reflects the fact that only few centres provide GA for children, and that some patients and their families are expected to travel significant distances to access care.

Relative distances of travelling must be considered especially in larger states such as NSW, where some patients may be required to travel six or more hours to access GA services at Westmead Hospital. This is an important factor as many dentists in smaller country areas may opt for other treatment modalities in order to avoid lengthy travelling times to tertiary referral centres such as Westmead Hospital. One US study reported on the likelihood of patients returning to their recall appointments with respect to the place of residence. It was found that patients who lived within the city of interest returned for recall significantly more than those who lived outside. This later group was more likely to return to their referring dentist (Enger and Mourino, 1985). Our follow up group in 1996 did not investigate this trend, although all patients referred from outside Sydney are advised to have a postoperative review visit by their local dentists. Seldom patients are required to attend the hospital a week later if they live more than 1.5 hours of travelling time.

Reason of referral

Most studies in the literature show that dental caries and its effects are the most common reason for the provision of GA in paediatric dentistry (Holt et al. 1991; Holt et al. 1992; Mason et al. 1995; McLaughlin et al. 1987; O'Sullivan and Curzon, 1991; Smallridge et al. 1990; Vermeulen et al. 1991). Of these, only seven studies provide data on the numbers of patients treated for caries under GA (see Table 1.6-page 68). Caries and its effects were the main reason for referral in our study, with a statistically significant increase from 70% in 1984 to 83% in 1996. These results are consistent with trends seen previously, and similar to three other studies (O'Sullivan and Curzon, 1991; Vermeulen et al. 1991; Holt et al. 1992). This increase in caries for our sample population is consistent with findings that there are still subgroups of the paediatric population with high caries (Blinkhorn and Davies, 1996; Widmer and Mekertichian, 1996; Davies et al. 1997). Given that the present study shows that most children are of pre-school age, and that there is an increasing percentage of Asian and Middle-Eastern children, this study is in agreement that these "susceptible" children are

mostly very young and come from specific ethnic backgrounds (Holt et al. 1991; Nunn et al. 1995; O'Sullivan and Curzon, 1991; Rule et al. 1967). Our results showed that approximately 27% of children presented with a medical condition in 1996. However, no difference was made between relative simple conditions (e.g. mild asthma or innocent heart murmurs) and those that significantly affect or limit everyday life (e.g. cyanotic heart disease and severe asthma). This means that this 27% figure may be higher than in reality as all patients with a medical background were included in this group. This figure is much lower than the two UK studies that specifically addressed the use of GA in medically compromised children (Harrison and Roberts, 1998; Nunn et al. 1995), but comparable to more general studies of GA in paediatric dentistry (O'Sullivan and Curzon, 1991; Vermeulen et al. 1991).

In 1996, general anaesthesia was used in 4.7% of children suffering from orofacial trauma and in 8% of those with dental anomalies. These small numbers may be due to the increased acceptance of treatment in more conventional ways, and also perhaps to the fact that a proportion of these children are seen by the department of Oral & Maxillofacial Surgery at this same hospital. In regards to extractions, our data gathering did not differentiate between extractions due to caries and those due to orthodontic reasons, whereas several UK studies account for an increase in the number of orthodontic extractions (Holt et al. 1992). Furthermore, no specific reference was made in our study about children with management and behaviour difficulties. The reason for this is that in most cases it is difficult to separate a cause as only due to caries, behaviour only, or as a combination of caries, young age of the patient and reluctance to accept treatment in conventional ways. In order to separate children into these categories, one would have to define at what age one considers a child mature enough to accept treatment in the dental chair. Similarly, one needs to determine what treatment is considered traumatic enough to warrant the use of GA. Therefore all children were categorised as caries related due to the inability to group patients in an objective manner.

Source of Referral

The referral pattern has been investigated extensively, with differences reported in each review. The trends not only vary between studies, but have also changed over time within particular institutions. This may be due to differences in health care services in countries and states over the past 30 years. Results of these findings in the literature have been described earlier in Table 1.7 (page 69). Our study found that out of the established referral sources, general dentists referred 20% of patients in 1996. This result may imply that children in Sydney do not frequently attend general dentists, or that the great majority of them do not have major dental problems. This is consistent with current dmft and DMFT values of Australian children. Although 20% is quite a low figure, GP dentists still made the most important group of referred patients, a finding consistent with other studies (Nunn et al. 1995; Vermeulen et al. 1991; Wong et al. 1997). This was closely followed by the School Dental Service (SDS) which referred 18% of children in 1996. The increase in 1996 in referral numbers from the SDS may be due to the introduction of the SOKS program (see page 81) which now screens a greater number of children in primary schools than the previous program. Studies from the UK have also shown that the Community Dental Service (CDS) is a strong referral source within their health system (Mitchell et al. 1985; Nunn et al. 1995; Smallridge et al. 1990). This is not supported by the Belgium study where less than 1% of patients where referred by the SDS (Vermeulen et al. 1991). It is apparent that the structure of the health system in each country affects the way children are referred to centers for the provision of GA.

Overall, emergency patients made up the largest group of children to subsequently need general anaesthesia in our study (42% in 1984 and 34% in1996). These are patients that have not accessed dental care by any other means and use Westmead Hospital as a primary health care provider. The results from this study suggest that patients of specific ethnic backgrounds (Middle-Eastern and Asian children) use this approach with increased

frequency as compared to other ethnic groups. Asian and Middle-Eastern patients accounted for 23.5% of all patients in 1996, however 48% of these children accessed the hospital through the emergency department (as compared with 30% of Anglo-Saxon children). This suggests that community based oral health promotion should be targeted at these groups. There are several possible reasons as to why self-referred patients are such a large group. The increase in certain ethnic groups may be explained by the fact that most of these patients are from specific suburbs in Sydney, they come from low socio-economic groups and therefore make use of the public health care system. These are closed ethnic societies where the knowledge of availability of dental services is thought to occur by word of mouth. Also, Westmead Hospital is a well-known referral centre and many patients are aware of the GA dental services available. Furthermore, the high cost of dental treatment in private practice means that many families cannot afford to attend a private dentist for routine dental care. Several other studies have found a significant proportion of self-referred patients accessing GA, which is in agreement with our results, but no explanation is given for their findings (Holt et al. 1992; Vermeulen et al. 1991; Wong et al. 1997). Only one study suggested that the high number of self-referred patients was due to the fact that a large number of children did not have their own dentist; and this could be due to apathy or lack of education/interest by the parents (Keniry, 1974).

In addition, our results showed a statistically significant increase in the number of children grouped as "Other" from 12% in 1984 to 19% in 1996. These are mainly children that have been referred from within the hospital in one way or another. It is therefore important to identify these patients with more accuracy as to determine why they are on the increase. A possible explanation could be that now children are seen in general dental departments throughout the hospital as compared to previous years when they were mainly seen in the Paediatric Dentistry Department. The reason for this is that now fewer dentists work in the paediatric dentistry unit due to increased financial restrictions within the hospital. The increase in internal referrals may suggest that general dentists and therapists may not be as

experienced in handling young children and therefore may abandon regular dental treatment. The net result is that attempts are made by inexperienced dentists to treat children. On failing, many such children are referred to Paediatric Dentistry for GA. Furthermore, several other children with high treatment needs and especially preschool children require specialist management care.

Waiting time

Waiting time is a term used in most studies in GA for children to quantify the demand for services provided. In other words, how efficiently a particular unit or hospital deals with the number of patients requiring treatment under GA. Our study showed that provision of GA was kept with the demand up until 1990 (Figure 5.1). From then on the number of GA sessions remained stable but demand for services outstripped the provision of services. Consequently, the average waiting time increased from 37 days in 1984 to 81 days in 1996.

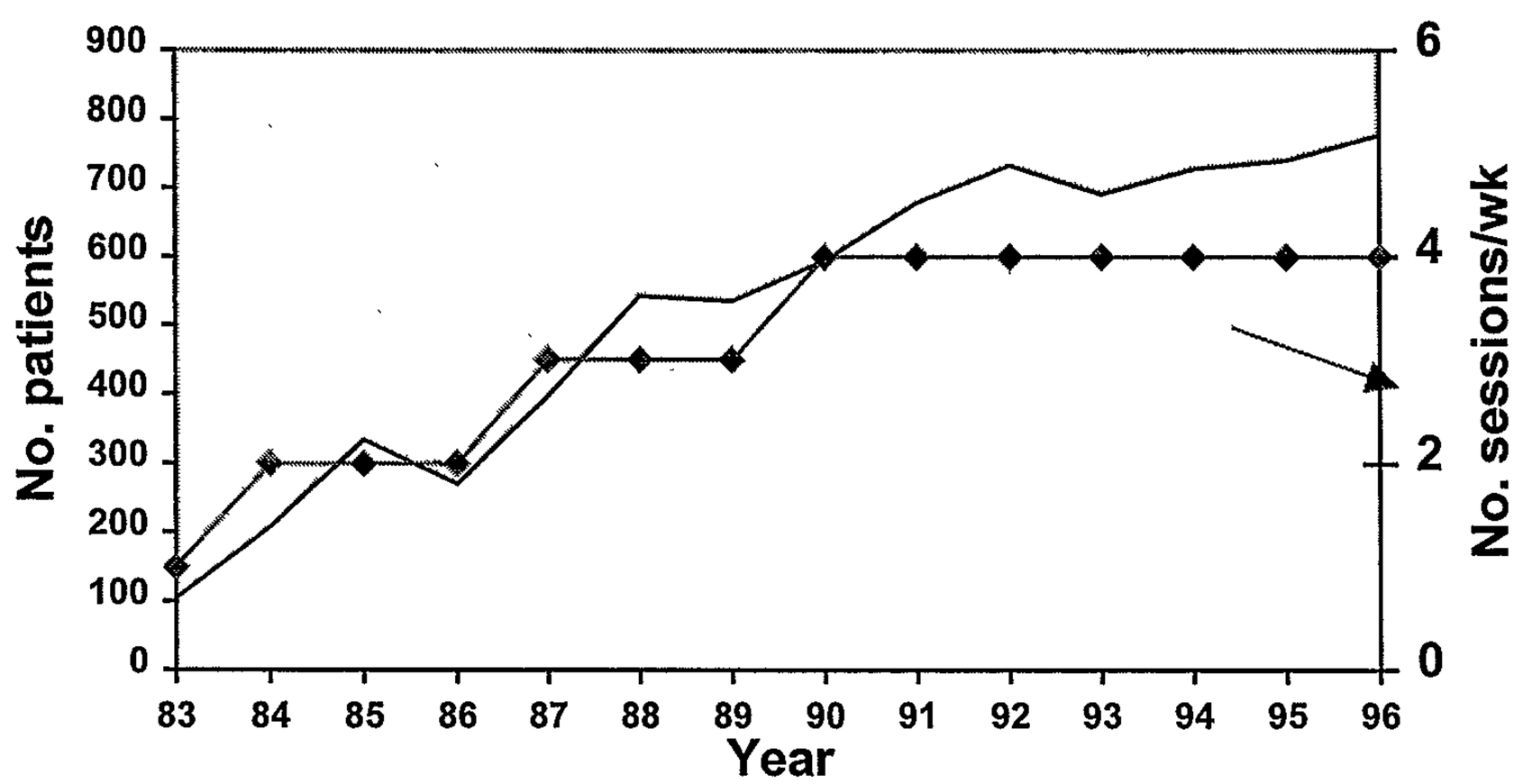

Figure 5.1: Number of GA patients and sessions per year.

In 1996, over two thirds (67%) of the children had to wait two or more months, and 39% had to wait three months or more to receive treatment under GA. These results are similar to a New Zealand study which found that mean waiting times more than doubled due to the increased demand (Thomson, 1994). Over the five-year period of this last study, only 3.4%

of children had to wait more than 3 months for treatment in 1989-1990 compared with 28.4% in 1993-1994. This was still significantly less than our results for the year 1996. Most other papers addressing waiting time are from the United Kingdom, where waiting times are considerably longer than our study and the New Zealand study. One UK review found a mean waiting time of 3.4 weeks for the initial consultation for a dental GA (Podesta and Watt, 1996). Although 90% of these parents reported that their referring dentist had explained why their child was being referred for a GA, 70% were not offered an alternative form of treatment before being referred. This was considered a major cause of concern as it is likely that a number of these children may have been appropriately managed in other ways thereby decreasing the demand and need for GA (Podesta and Watt, 1996). A waiting period between 10 to 12 weeks was reported in one UK study. This was despite an increase in the provision of facilities from 4 operating lists per month in 1972 to 10 per month in 1992 (Mason et al. 1995). Another study reported waiting times between four to nine months (O'Sullivan and Curzon, 1991). This is in accordance with a ten-year review on the use of GA in children, which found that although the number of patients increased only slightly from 1988 to 1995, the waiting time increased from four to nine months (Wong et al. 1997). Service availability was not specifically addressed in these studies and this presents difficulties when comparing waiting times among different hospitals or institutions.

The results of our study showed that the increase in number of GA sessions per month (from 8 in 1984 to 16-18 in 1996) did not translate in a decrease in waiting times. Several reasons may account for this increase in waiting times. The demand may have increased as more health and dental professionals within the community are aware of the availability of GA in this specialist unit. Also, increased restrictions to provide GA in private practices may have lead to fewer procedures being carried out. Furthermore, with changes to the public sector and the introduction of the SOKS program, this may have well increased the number of children requiring GA. Our results showed that the number of children referred for GA by the SDS increased from 12% in 1984 to 18% in 1996. Lastly, the results suggest that there

are more children with high treatment needs who may require longer operating times and therefore decrease the number of children seen per operating session. This finding is consistent with current trends in caries distribution (Blinkhorn and Davies, 1996; Spencer et al. 1994) and demographic characteristics (Thomson, 1993) reported in the literature.

Treatment provided

The results of our study showed that the majority of the treatment done was in the primary dentition. This is consistent with the finding that most children requiring GA were below the age of six years. In the primary dentition, there was a significant increase in the number of extractions made and some definite trends in the restorative treatment carried out between the two periods. Results in the permanent dentition also showed specific trends, with an increase in the number of fissure sealants being the most significant change. These results will be discussed in some detail and compared to relevant papers in the literature. Extractions and restorations, and to a lesser degree surgical procedures are the most commonly mentioned procedures carried out under GA in children. A good summary of services provided in the UK over a ten-year period showed that nearly three times as many primary teeth compared with permanent teeth were restored. Primary teeth were extracted far more often (5:1) than permanent teeth. It also showed that only 23% of teeth treated with pulpotomy procedures received a stainless steel crown (Wong et al. 1997).

Extractions

General anaesthesia has often been used for the extraction of teeth particularly in children but also in adults. The most common reason is dental caries and its sequelae. Our study found a significant increase in the number of primary teeth extracted between the two periods. The mean number of primary teeth extracted per child increased from 1.98 in 1984 to 3.11 in 1996. The overall number of children having primary teeth extracted increased

significantly from 59% in 1984 to 79% in 1996. These figures are similar to other studies assessing the number of extractions done under GA. One early study on the use of GA in 225 children showed that the average number of teeth extracted in the primary dentition was 3.8 per child, as compared to 2.8 in the permanent dentition (Rule et al. 1967). The extraction ratio for permanent teeth was quite high for this UK study, but this may be due to the early date of the paper (when caries levels in the UK were generally much higher) and the lack of water fluoridation in London at the time. In comparison, a study in 1974 of 1307 child patients showed that the average number of extracted teeth was 2.3 per case, but did not specify whether primary or permanent; however the peak age quoted was 5 years of age (Keniry, 1974). Other recent studies have also found an increase in the number of teeth extracted per child under GA. One paper reported a mean of 4.1 teeth extracted per child, a number higher than the mean 6 years earlier (Smallridge et al. 1990). A multi-centre study corroborated these results and reported that 83% of the anaesthetics were given for the extraction of primary teeth, with an average of 3.3 teeth per child (Holt et al. 1992). However, these two last studies were done in children having GA extractions only, as opposed to comprehensive care. Similarly, another study (where nearly 70% of children had some form of disability or medical condition) found a mean value of 3.6 teeth extracted per child (for primary teeth) and 2.9 (for permanent teeth) showing an overall increase in the number of teeth extracted (Nunn et al. 1995).

There is general support for the fact that more radical treatment should be carried out on these children in order to avoid repeat procedures in the near future (Nunn et al. 1995). This is not only warranted in medically compromised children, but also in those with high levels of disease and those children that are difficult to treat in more conventional ways. Another consideration is the constant demand and increasing waiting lists affecting most centres providing GA. By carrying out more extractions per child, a greater number of children can be seen per operating lists.

Statistically significant increases in the number of patients having only one primary tooth extracted and 5-8 extractions were noted in our study when comparing 1984 with 1996. This may suggest an increase in the number of children requiring the extraction of a single traumatised tooth. The reason for having more of these trauma cases may be due to increased awareness of services, but also individual management styles of particular clinicians and the fact that regular sessions allow "quick" cases to be added on request. The increase in the group of children having 5-8 extractions highlights the fact that children with high levels of disease are seen, and that more radical treatment is implemented.

Other studies have found the opposite to be true, with fewer patients having extractions under GA. Our study did find a decrease in the number of patients having permanent teeth extracted, with a decline from 11% in 1984 to 6% in 1996. Our mean number of permanent extractions *per* patient of 0.1 in 1996 was much lower than the value of 2.9 given by a recent UK study (Nunn et al. 1995). This may be due to the different nature of our patient population, with children mostly of preschool age, fewer medically compromised children (27%, compared to nearly 70% in the UK study), water fluoridation, and a more conservative treatment approach when dealing with first permanent molars. This is consistent with a 25-year review of GA usage in Leeds, UK (1960-1984) which showed a fall in the number of permanent teeth extracted annually (McLaughlin et al. 1987).

Water fluoridation has been suggested to have an effect in the number of extractions of children having treatment under GA (Chippendale and Storey, 1988). This Australian study (Melbourne, 1977-1986) found a decrease in the number of extractions of 80% for children aged 1 to 7 years, and suggested that this was due to the introduction of water fluoridation. No such correlation was investigated in the Sydney study. However, both studies found a proportion of children with higher levels of dental disease that on average required more extractions. This last finding is also consistent with current trends of caries in Australia (Davies et al. 1997; Widmer and Mekertichian, 1996).

Treatment of the primary and permanent dentition

Restorative treatment carried out under general anaesthesia can be generally subdivided into treatment in the primary or permanent dentitions (Wong et al. 1997). Unfortunately many studies do not make distinction between the two dentitions and only quote number of restorations or procedures performed (Keniry, 1974; Enger and Mourino, 1985; O'Sullivan and Curzon, 1991). Several studies also describe treatment procedures by comparing the number of restorations and trends in use of particular materials between two or more periods of time (Bohaty and Spencer, 1992; Nunn et al. 1995; Wong et al. 1997).

In the current study the mean number or restorations in the primary dentition decreased slightly (from 4.84 in 1984 to 4.05 in 1996). However, the restoration/extraction ratio for the primary dentition decreased markedly from 2.4 in 1984 to 1.3 in 1996. This last value is similar to the ratio found by one UK study, which quoted a restoration:extraction ratio for primary and permanent teeth of 1.2 and 2.3 respectively (Wong et al. 1997). These ratios were higher than that reported by another study (0.8 and 0.6 for primary and permanent teeth respectively) (Mason et al. 1995). The overall restoration:extraction ratio in the study by Wong and coworkers was 1.3, which is similar to that reported by others (O'Sullivan and Curzon, 1991; Tarjan et al. 1990). The decrease in our restoration:extraction ratio can be mostly attributed to the increase in the number of extractions.

In regards to the materials used, the most interesting result was that no amalgams or stainless steel crowns (SSCs) were recorded in 1984. Glass ionomer restorations were by far the most popular material in 1984. It is interesting to note that although the number of glass ionomer restorations nearly halved from 1984 to 1996, the actual number of patients receiving this treatment modality remained virtually unchanged. It is hypothesised that in 1984 glass ionomers were recently introduced as a restorative material and due to its properties (fluoride release and bonding capacity) were chosen in preference to the more conventional

amalgam and composite restorations. However, subsequently the literature has shown them to be inadequate in terms of clinical durability (Welbury et al. 1991). This information has lead to a change in treatment philosophy with other materials such as amalgam, composite and SSCs regaining popularity.

In regards to the permanent dentition it can be seen that the number of fissure sealants increased significantly in 1996. This is consistent with other studies that have compared two periods of time and have shown statistical increases in the use of sealants (Nunn et al. 1995; Bohaty and Spencer, 1992). The reason for this change stems from the evidence for fissure sealants in the prevention of occlusal caries (Manton and Brearley Messer, 1995). Since our population seems to have large numbers of children with high levels of disease, maximising preventive strategies is important. A decrease in the number of glass ionomer restorations was also noted in the permanent dentition, a finding consistent with the limited use and lifespan of this material and the availability of more durable materials such as amalgam and composite resins.

Surgical procedures

The description of surgical procedures in children under general anaesthesia is limited to a few studies with varied results (Table 1.9, page 71). The most common reported procedures are removal of supernumerary teeth (including odontomes), surgery related to orthodontic procedures (eg. exposure +/- bonding of unerupted teeth, removal of impacted teeth), and minor soft tissue surgery (frenectomies, biopsies and removal of soft tissue lesions). Our study found a decrease in the number of surgical procedures being performed in the Paediatric Dentistry department under GA. The number of children receiving surgery decreased significantly from 20% in 1984 to 12% in 1996. There are several possible explanations for this result. The most likely one is the fact that more children requiring surgery are currently being referred to the department of OMFS. Only minor oral surgery is

performed in our department with one consultant paediatric dentist performing most of these procedures. It is also possible that some procedures may be delayed to a later stage in development (e. g. removal of a supernumerary tooth) in order to minimise complications of the surgery. This would mean that many children might be older, maturer and therefore able to receive treatment in the chair rather than under GA.

In a comprehensive study addressing surgical procedures, a 200% increase in surgery was reported over a 20 year period at a London dental hospital (Mason et al. 1995). This study assessed changes in treatment provided for children under general anaesthesia between 1972-1992. It was found that the main use of GA was still for the management of caries, but oral surgery procedures, especially those related to orthodontic treatment increased significantly in the last decade of the study. Only two out of 202 children were recorded as having a surgical procedure in 1972, but by 1982 the number increased to 18% (53 out of 287). This figure further increased to 34% (157 out of 465) in 1992, with a very marked increase in the number of children having a tooth surgically exposed (+/- bonding of an orthodontic attachment). This increase in orthodontically related minor oral surgery was attributed to the interests and skills at that particular centre. It also reflected links between the departments of children's dentistry and orthodontics and a combined approach to treatment planning. The mean age of patients having surgery in our study was 8.56 years in 1984 and 8.23 years in 1996. This is clearly much older than the overall population, where the average was 5.39 years in 1984 and 5.25 years in 1996. The study by Mason and others found and older age group in their population, with 50% of patients being 10 years or older in 1992 (Mason et al. 1995).

Other characteristics

Medical Condition

All patients were screened for medical conditions and classified as "none" and "medical". The results showed that the number of patients increased from 22% in 1984 to 27% in 1996, however this increase was not statistically significant. These results are similar to those found by other studies (Rule et al. 1967; Keniry, 1974; Holt et al. 1991; O'Sullivan and Curzon, 1991). This increase in the number of medically compromised children may be related to the relocation of the New Children's Hospital (NCH) in proximity to the Westmead Dental School (WDCS). It can be argued that more medically compromised children are now referred to the unit for dental GAs, however no clear evidence can be found in the referral patterns of our sample population. Children requiring admission to hospital for their dental work under GA are usually seen at the NCH, where a dental operating list also exists but it is not accounted for in our study.

The Sydney study did not find a significant number of teenage children with special needs due to the fact that most of this patients are seen in the "Special Care Unit" at this same hospital. A study that evaluated the use of GA in children with special needs found that 60% (350 out of 586 children) of their patients had medical and/or mental disabilities, a finding that was expected. Although the number of peri-operative admissions was low (11 planned and 9 emergency), this study highlighted the necessity for these patients to be treated in a hospital (Wong et al. 1997). This high proportion of medically compromised children has also been reported in studies of GA in children with special needs (Nunn et al. 1995; Harrison and Roberts, 1998). A recent study reporting on the dental health of chronically sick children found that dental disease was extensive across the spectrum of medical conditions (Harrison and Roberts, 1998). Furthermore, there was a predominance of extractions over restorations in these children and this treatment modality was a result of the treatment planning philosophy for these patients. The authors concluded that the dental

treatment of chronically sick children under GA is significantly influenced by the underlying medical disorder. The Sydney study did not evaluate this finding, but individual patient notes seem to support this approach to treatment. One final observation about our population is the fact that no distinction was made among patients with moderate to severe chronic illnesses and those with mild conditions that do not affect their everyday life. This may have further increased the proportion of children categorised as medically compromised when in fact the number was actually lower than the one quoted.

Follow Up

The success of general anaesthesia in children has been measured in terms of the success of individual procedures performed and also the need to perform repeat GA procedures within a certain time span. Most papers do not directly mention follow up procedures in their samples and only a few quote figures for specific procedures. Our study recorded a significant increase in the number of children failing to attend follow up visits a week later after their GA (13% in 1984 compared to 25% in 1996). This is highly significant as it is hypothesised that many of these children have high treatment needs, come from specific ethnic backgrounds and have habits associated with high caries risk. It would be interesting to note how many of these children require further dental treatment within a five-year period. Comparatively, there was a significant increase (30% in 1984 to 39% in 1996) in the number of children attending for a single review visit. This finding may be due to the desire of parents to have all treatment checked, while subsequent follow-ups can be done by their local dentist. Many other children that received treatment under GA were recalled regularly and for longer periods of time in 1984. At present, most of these children are referred back to their practitioners for continuing care. These changes are due to new departmental protocols in order to reduce waiting lists, and in line with current GA follow up trends in other parts of the world (Vermeulen et al. 1991; Holt et al. 1991; Berkowitz et al. 1997).

The early study by Rule and others assessed follow up with regards to the ability of the dentist to carry out restorative procedures in the mouth without repeated use of general anaesthesia (Rule et al. 1967). The average follow up time was 6 to 12 months. Out of 225 patients, 21% (48 cases) responded favourably to further dental treatment in the chair, with the majority of these children being under 10 years of age. Eight patients (3.5%) remained impossible to treat. Our study did not investigate the future behaviour of children to further treatment, and this area needs further investigation in order to assess the response of this group of patients. The study by Rule also commented on the inadequacy of follow up of many of these patients. This group involved patients that had: surgical procedures that did not require further treatment; patients that failed to attend subsequent appointments; patients that were subsequently treated by their dentists; or patients for whom no follow up notes were entered in their records (Rule et al. 1967).

Repeat GAs

The number of repeat GAs in our study could only be assessed for the year 1984. It was found that 16.4% (31 out of 189) of children underwent a second (or more) procedure within the overall period of the study, that is for the 12-year period examined. Of these children, most repeat GAs were for the treatment of caries and to a lesser extent for surgical procedures. This is consistent with the study by Keniry in 1974 that found the majority of patients had only one anaesthetic experience for dental treatment. In this study, out of a total of 1,307 children, 166 (12.7%) had two general anaesthetics, 27 had three sessions, and 4 patients had four GAs. This gives a figure of 17.8% return visits for a time interval raging from three days to four years. The most frequent revisits occurred in children between the ages of 4-8 years (Keniry, 1974). More recent studies have quoted figures of 5% (Smallridge et al. 1990), 2.5% (O'Sullivan and Curzon, 1991), 4.2% (Thomson, 1994), and 12% (Nunn et al. 1995) for repeat general anaesthetics in children. Only the study by Nunn and others (mostly medically compromised patients) specifically mentioned that children required

further treatment within 5 years of their previous visit (Nunn et al. 1995). Future work needs to be done to look at the number of repeat GAs in our 1996 group. It is possible that with the significant increase in the number of extractions in 1996, the number of repeat GAs may have decreased.

Limitations of the study

The extraction of information from notes in a retrospective manner has limitations. This type of study involves interpreting information written in medical records by several different operators. Not all information is always available. The fact that notes from 1984 were used meant that several records could not be found. In order to minimise errors during data collection, patient files were compared with computer printouts, operation records and anaesthetic records. This assured that the data being recorded was accurate in most cases, but it could not be verified for some. It was not possible to find out what proportion of patients that attend the Paediatric Dentistry department at Westmead Hospital actually required a general anaesthetic. At the time of this study, the number of occasions and the number of new patients were only recorded. There is no record of the total number of patients seen at this unit per year, therefore it was impossible to work out the percentage of patients requiring general anaesthesia. Assigning ethnicity to patients was difficult in our study. Patient files did not always record this information accurately. Therefore other data such as the country of birth, time living in Australia, language spoken at home, and citizenship had to be taken into account when assigning ethnicity. It is possible then that the interpretation of this data may be biased, and this must be taken into consideration.

The financial cost involved in the provision of GA services is substantial for any institution, therefore recording data such as health insurance of the patients treated is extremely relevant. Westmead Hospital is primarily a public hospital and as such, most patients seen

are public or "Medicare" holders. This is reflected in our sample of 1984 where 70% of children treated under GA were classified as Medicare patients and 30% as holders of private insurance. However, most of the 30% that had private insurance were not billed accordingly, and therefore they were still treated as "public" patients. A significant drop in private patients was seen in 1996 with only 1% recorded as private. The main reason for this change may well be the lack of entry of the relevant information. In other words, this 1% figure is likely to be inaccurate. It is also possible that patients that hold private insurance may not disclose this information and therefore increased the burden on the public sector. This finding has immense repercussions in financial terms for any institution. Since it is clear that demand for this type of service is on the rise, this information is vital for any major institution providing such costly services as dental general anaesthesia.

The morbidity experienced during day-stay surgery could not be assessed due to lack of information and the fact that no protocol is currently in force to record such data. However, the most common post-operative complications in our patients were nausea, vomiting, sore throat and oral pain.

CHAPTER 6 . CONCLUSIONS

At the beginning of this study several objectives were outlined, with the main purpose of answering five postulates:

1. The number of children receiving dental care under general anaesthesia has increased over the past 13 years.

This study supports this postulate. There was over a seven fold increase in the number of patients treated under GA between 1983 (105 children) and 1996 (777 children).

2. The demographic, socio-economic, and cultural characteristics of these patients have altered over the past 13 years.

There were no significant changes in the place of residence between the two years examined. Most patients came from the Western Sydney area (where Westmead Hospital is located) and the Southwestern area. Socio-economic variables proved difficult to examine as there was insufficient data.

3. That young children from specific ethnic backgrounds make up an increasing proportion of patients requiring extensive dental treatment under GA.

This study showed that in 1996 children of Asian and Middle-Eastern origin made an increasingly important group. Several of these children came from low socio-economic backgrounds, many were born overseas, and a significant proportion presented with high levels of dental disease. The distribution in ethnic groups in our sample is thought to be a reflection of the overall child Sydney population.

4. The treatment need of the children receiving dental care under GA over the past 12 years has changed with increasingly complex restorative work being required.

This finding was not corroborated and in fact, the opposite appeared to be true, with treatment plans involving more extractions and more radical treatment philosophies.

5. That the demand for dental GA has been met by the service commitment as assessed in terms of the length of the waiting list.

This was not the case as demand continued to increase and from 1990 demand outstripped the provision of services, with the average waiting time increasing from 37 days to 81 in 1996.

REFERENCE LIST

1. Abramowitz, M.D., Oh, T.H. and Epstein, B.S. (1983) The antiemetic effect of droperidol following outpatient strabismus surgery in children. *Anesthesiology* **59**, 579-583.

2. Abu-Saad, H. (1984) Assessing children's responses to pain. *Pain* **19**, 163-171.

3. Ahlgren, E.W., Bennett, E.J. and Stephen, C.R. (1971) Outpatient pediatric anaesthesiology: a case series. *Anesth.Analg.* **50**, 402-408.

4. Aka, W. and Jedrychowski, J.R. (1995) Intraoperative and postoperative physiological monitoring practices by pediatric dentists. *J.Clin.Pediatr.Dent.* **19**, 91-98.

5. Alexander, D.W., Graff, T.D. and Kelley, E. (1965) Factors in tonsillectomy mortality. *Arch Otolaryngol.* **82**, 409-411.

6. Alfonzo Echeverri, E.C., Berg, J.H., Wild, T.W. and Glass, N.L. (1993) Oral ketamine for pediatric outpatient dental surgery sedation. *Pediatr.Dent.* **15**, 182-185.

7. Alvesalo, I., Murtomaa, H., Milgrom, P. and Honkanen, A. (1993) The dental fear survey schedule: a study with Finnish children. *Int.J Paediatr.Dent* **3**, 193-198.

8. Alwin, N., Murray, J.J. and Niven, N. (1994) The effect of children's dental anxiety on the behaviour of a dentist. *Int.J.Paediatr.Dent.* **4**, 19-24.

9. Alwin, N.P., Murray, J.J. and Britton, P.G. (1991) An assessment of dental anxiety in children. *Br.Dent J* **171**, 201-207.

10. American Academy of Pediatric Dentistry (1985) Guidelines for the elective use of conscious sedation, deep sedation, and general anesthesia in pediatric patients. *Pediatr.Dent* **7**, 334-337.

11. American Academy of Pediatric Dentistry (1993) Guidelines for the elective use of pharmacologic conscious sedation and deep sedation in pediatric dental patients. *Pediatr.Dent* **15**, 297-301.

12. Armitage, E.N., Howat, J.M. and Long, F.W. (1975) A day-surgery program for children incorporating anaesthetic outpatient clinic. *Lancet* **2**, 21-23.

13. Armstrong, M.H. (1965) The History of Anaesthesia. In: Evans, F.T. and Gray, T.C., (Eds.) *General Anaesthesia*, 2nd Edition edn. pp. 1-17. London: Butterworths.

14. Australian and New Zealand College of Anaesthetists Australian and New Zealand College of Anaesthetists, (Ed.) (1995a) Guidelines for the care of patients recovering from anaesthesia. P4, pp.1-4. Melbourne.

15. Australian and New Zealand College of Anaesthetists Australian and New Zealand College of Anaesthetists, (Ed.) (1995b) Guidelines for the perioperative care of patients selected for day care surgery. P15, pp.1-3. Melbourne.

16. Australian and New Zealand College of Anaesthetists Australian and New Zealand College of Anaesthetists, (Ed.) (1995c) Monitoring during anaesthesia. P18, pp.1-4. Melbourne.

17. Australian and New Zealand College of Anaesthetists Australian and New Zealand College of Anaesthetists, (Ed.) (1995d) Recommended minimum facilities for safe anaesthetic practice in dental surgeries. T5, pp.1-7. Melbourne.

18. Australian and New Zealand College of Anaesthetists Australian and New Zealand College of Anaesthetists and Royal Australasian College of Dental Surgeons, (Eds.) (1996) Sedation for dental procedures . P21, pp.1-6. Melbourne.

19. Barclay, J.K. (1974) General anaesthesia for dental surgery. *N.Z.Med.J.* **79**, 816-820.

20. Barnard, P. (1989) Letter to the NHMRC Working Group on the effectiveness of water fluoridation. Unpublished.

21. Barnard, P. (1990) Letter to the NHMRC Working Group on the effectiveness of water fluoridation. Unpublished.

22. Barr, E.B. and Wynn, R.L. (1992) IV sedation in pediatric dentistry: an alternative to general anesthesia. *Pediatr.Dent.* **14**, 251-255.

23. Berkowitz, R.J., Moss, M., Billings, R.J. and Weinstein, P. (1997) Clinical outcomes for nursing caries treated using general anesthesia. *ASDC.J Dent Child* **64**, 210-1, 228.

24. Berry, F.A., Jr., Blankenbaker, W.L. and Ball, C.G. (1973a) A comparison of bacteremia occurring with nasotracheal and orotracheal intubation. *Anesth.Analg.* **52**, 873-876.

25. Berry, F.A., Jr., Yarbrough, S., Yarbrough, N., Russell, C.M., Carpenter, M.A. and Hendley, J.O. (1973b) Transient bacteremia during dental manipulation in children. *Pediatrics* **51**, 476-479.

26. Bishop, C. and Potts, M.W. (1961) Complications of outpatient dental anaesthesia. *Br.Dent.J.* **111**, 235-244.

27. Blinkhorn, A.S. and Davies, R.M. (1996) Caries prevention. A continued need worldwide. *Int.Dent.J.* **46**, 119-125.

28. Bohaty, B. and Spencer, P. (1992) Trends in dental treatment rendered under general anesthesia, 1978 to 1990. *J.Clin.Pediatr.Dent.* **16**, 222-224.

29. Boulanger, T. (1990) General anesthesia in pedodontic practice: a survey of 46 cases . *J Pedod.* **14**, 108-109.

30. Bourne, J.G. (1970) Deaths with dental anaesthetics. *Anaesthesia* **25**, 473-481.

31. Braid, D.P. (1989) Anaesthesia for Dental Surgery. In: Nimmo, W.S. and Smith, G., (Eds.) *Anaesthesia*, 1st edn. pp. 654-664. London: Blackwell Scientific Publications.

32. Brett, C.M., Zwass, M.S. and Knudsen, N. (1994) Eyes, ears, nose, throat, and dental surgery. In: Gregory, G.A., (Ed.) *Pediatric Anesthesia*, 3rd edn. pp. 657-697. New York: Churchill Livingstone.

33. Britt, B.A. and Kalow, W. (1970) Malignant hyperthermia: a statistical review. *Can.Anaesth.Soc.J* **17**, 293-315.

34. Brown, J.P., Junner, C. and Liew, V. (1985) A study of *Streptococcus mutans* levels in both infants with bottle caries and their mothers. *Aust.Dent.J.* **30**, 96-98.

35. Bryant, C.J., Crean, S.J. and Hopper, C. (1997) Maxillofacial surgery and the role of the extended day case. *Br.Dent.J.* **182**, 134-138.

36. Calache, H. and Wright, F.A. (1987) The dental status of four-year-old children in the Brunswick Child Development Study. *Aust.Dent J* **32**, 126-131.

37. Cameron, A.C. and Widmer, R.P. (1997) *Handbook of Pediatric Dentistry*, 1st edn. London: Mosby.

38. Camm, J.H., Mourino, A.P., Cobb, E.J. and Doyle, T.E. (1987) Behavioral changes of children undergoing dental treatment using sedation versus general anesthesia. *Pediatr.Dent.* **9**, 111-117.

39. Campbell, R.L. (1986) Prevention of complications associated with intravenous sedation and general anesthesia. *J.Oral Maxillofac.Surg.* **44**, 289-301.

40. Campbell, R.L., Weiner, M. and Stewart, L.M. (1982) General anesthesia for the pediatric patient. *J.Oral Maxillofac.Surg.* **40**, 497-506.

41. Carr, L.M. (1972) Fluoridation in Canberra. II. Dental caries after six years. *Aust.Dent J* **17**, 335-339.

42. Carr, L.M. (1976) Fluoridation in Canberra. III. Dental caries after ten years. *Aust.Dent J* **21**, 440-444.

43. Carr, L.M. (1988) Dental health of children in Australia, 1977-1985. *Aust.Dent.J.* **33**, 205-211.

44. Chadwick, R.G. and Lindsay, S.M. (1996) Dental injuries during general anaesthesia. *Br.Dent J* **180**, 255-258.

45. Chadwick, R.G. and Lindsay, S.M. (1998) Dental injuries during general anaesthesia: can the dentist help the anaesthetist? *Dent Update.* **25**, 76-78.

46. Chapman, P.J. (1988) A controlled comparison of effectiveness of bupivicaine for post-operative pain control. *Aust.Dent.J.* **33**, 288-290.

47. Chippendale, I. and Storey, E. (1988) Declining attendances for general anaesthesia and tooth extractions in children following the fluoridation of Melbourne. *Aust.Dent.J.* **33**, 415-419.

48. Cohen, M.M., Duncan, P.G., Pope, W.D. and Wolkenstein, C. (1986) A survey of 112,000 anaesthetics at one teaching hospital (1975-83). *Can Anaesth.Soc.J* **33**, 22-31.

49. Colquhoun, J. (1990) Flawed foundation: a re-examination of the scientific basis for a dental benefit from fluoridation. *Community.Health Stud.* **14**, 288-296.

50. Commonwealth Department of Health (Ed.) (1984) Fluoridation of water in Australia. Canberra: Australian Government Printing Service.

51. Commonwealth Department of Health (1987) Dental health of children in Australia, 1977-1986. Canberra: Australian Government Printing Service.

52. Cooper, J.B. (1978) Preventable anesthesia mishaps: A study of human factors. *Anesthesiology* **49**, 399-406.

53. Coplans, M.P. and Curson, I. (1973) Deaths associated with dental general anaesthesia. *Br.Med.J.* **i**, 109-110.

54. Coplans, M.P. and Curson, I. (1982) Deaths associated with dentistry. *Br.Dent J* **153**, 357-362.

55. Coplans, M.P. and Curson, I. (1993) Deaths associated with dentistry and dental disease 1980- 1989 [see comments]. *Anaesthesia* **48**, 435-438.

56. Costarino, A.T., Davis, D.A. and Kean, T.P. (1987) Falsely normal saturation reading with the pulse oximeter. *Anesthesiology* **67**, 830-831.

57. Cote, C.J., Rolf, N. and Liu, L.M. (1991) A single blind study of combined pulse oximetry and capnography in children. *Anesthesiology* **74**, 980-987.

58. Craig, W. (1971) Hand over mouth technique. *J.Dent.Child* **38**, 387-389.

59. Crawford, A.N. (1990) The use of nitrous oxide-oxygen inhalation sedation with local anaesthesia as an alternative to general anaesthesia for dental extractions in children. *Br.Dent.J.* **168**, 395-398.

60. Crisp, M.P. Report of the Royal Commissioner, (Ed.) (1968) The fluoridation of public water supplies. Hobart, Tasmania: Government Printer.

61. Davenport, E.S. (1990) Caries in the preschool child: Aetiology. *J Dent* **18**, 300-333.

62. Davies, M.J. (1993) The Child Fluoride Study: pattern of fluoride exposure. Presented at the Concensus Conference on Appropriate Fluoride Exposure for Infants and Children, Perth 2-3 December, 1993.

63. Davies, M.J., Spencer, A.J. and Slade, G.D. (1997) Trends in dental caries experience of school children in Australia-1977 to 1993. *Aust.Dent.J.* **42**, 389-94.

64. Delbridge, A. and Bernard, J.R. (1995) *The Macquarie Concise Dictionary*, 2nd edn. Sydney: The Macquarie Library Pty Ltd.

65. Dental Health Branch, N.H. (1996a) NSW oral health program for kids -SOKS- Save Our Kids Smiles. *ADA Newsletter* 9 Sydney, NSW: Australian Dental Association (NSW Branch).

66. Dental Health Branch, N.H. (1996b) SOKS Overview. Sydney, NSW: NSW Department of Health.

67. Diesendorf, M. (1986) The mystery of declining tooth decay. *Nature* **322**, 125-129.

68. Diesendorf, M., Colquhoun, J., Spittle, B.J., Everingham, D.N. and Clutterbuck, F.W. (1997) New evidence on fluoridation [see comments]. *Aust.N.Z.J Public Health* **21**, 187-190.

69. Downer, M.C. (1992) Time trends in caries experience of children in England and Wales. *Caries Research* **26**, 466-472.

70. Downer, M.C. (1994) Caries prevalence in the United Kingdom. *Int.Dent.J.* **44**, 365-370.

71. Driscoll, E.J. (1978) Dental anesthesiology: its history and continuing evolution. *Anesth.Prog.* **25**, 143-152.

72. Drummond, B.K., Williams, S., Thompson, H. and Tam, M. (1996) Review of children receiving comprehensive restorative care under general anaesthesia. *European Academy Of Paediatric Dentistry* **3rd Congress**, 51-51.(Abstract)

73. Duncan, W.K., De Ball, S. and Perkins, T.M. (1994) Chloral hydrate sedation: a simple technique. *Compendium.* **15**, 884, 886-8, 890 passim.

74. Duncan, W.K., Pruhs, R.J., Ashrafi, M.H. and Charles Post, A. (1983) Chloral hydrate and other drugs used in sedating young children: a survey of American Academy of Pedodontic Diplomates. *Pediatr.Dent.* **5**, 252-256.

75. Enger, D.J. and Mourino, A.P. (1985) A survey of 200 pediatric dental general anesthesia cases. *ASDC.J.Dent.Child* **52**, 36-41.

76. Fisch, C., Oehler, R.C., Miller, J.R. and Redish, C.H. (1969) Cardiac arrhythmias during oral surgery with halothane-nitrous- oxide-oxygen anesthesia. *JAMA* **208**, 1839-1842.

77. Fisher, S.E., Frame, J.W. and Rout, P.G. (1988) Factors affecting the onset and severity of pain following the surgical removal of unilateral impacted mandibular third molar teeth. *Br.Dent J* **164**, 351-354.

78. Flaitz, C.M. and Nowak, A.J. (1985) Evaluation of the sedative effect of rectally administered diazepam for the young dental patient. *Pediatr.Dent.* **7**, 292-296.

79. Fuks, A.B., Kaufman, E., Ram, D., Hovav, S. and Shapira, J. (1994) Assessment of two doses of intranasal midazolam for sedation of young pediatric dental patients. *Pediatr.Dent.* **16**, 301-305.

80. Fung, D.E., Cooper, D.J., Barnard, K.M. and Smith, P.B. (1993) Pain reported by children after dental extractions under general anaesthesia: a pilot study. *Int.J.Paediatr.Dent.* **3**, 23-28.

81. Gokli, M.A., Wood, A.J., Mourino, A.P., Farrington, F.H. and Best, A.M. (1994) Hypnosis as an adjunct to the administration of local anesthetic in pediatric patients. *ASDC.J Dent Child* **61**, 272-275.

82. Gold, B.S., Kitz, D.S., Lecky, J.H. and Neuhaus, J.M. (1989) Unanticipated Admission to the Hospital Following Ambulatory Surgery. *J.Am.Med.Assoc.* **262**, 3008-3010.

83. Goldman, V. (1960) Halothane in the dental surgery. *Br.Dent J* **109**, 259-268.

84. Goodson, J.M. and Moore, P.A. (1983) Life-threatening reactions after pedodontic sedation: an assesment of narcotic, local anesthetic, and antiemetic drug interaction. *J.Am.Dent.Assoc.* **107**, 239-245.

85. Gregory, G.A. (1994a) Monitoring during surgery. In: Gregory, G.A., (Ed.) *Pediatric Anesthesia*, 3rd edn. pp. 261-279. New York: Churchill Livingstone Inc.

86. Gregory, G.A. (1994b) *Pediatric Anesthesia*, 3rd edn. New York: Churchill Livingstone Inc.

87. Gregory, G.A. (1994c) Pharmacology. In: Gregory, G.A., (Ed.) *Pediatric Anesthesia*, 3rd edn. pp. 13-45. New York: Churchill Livingstone Inc.

88. Grytten, J., Holst, D., Dyrberg, L. and Faehn, O. (1989) Some characteristics of patients given dental treatment under general anesthesia. *Acta Odontol.Scand.* **47**, 1-5.

89. Haden, R.M. (1985) Cardiac dysrhythmias during dental surgery: a comparison of halothane and enflurane in children. *Br.Dent.J.* **158**, 23-24.

90. Hallonsten, A.L., Koch, G. and Schroder, U. (1983) Nitrous oxide-oxygen sedation in dental care. *Community.Dent.Oral Epidemiol.* **11**, 347-355.

91. Hannallah, R.S., Baker, S.B., Casey, W., McGill, W.A., Broadman, L.M. and Norden, J.M. (1991) Propofol: effective dose and induction characteristics in unpremedicated children. *Anesthesiology* **74**, 217-219.

92. Hannallah, R.S. and Epstein, B.S. (1994) Outpatient Anaesthesia . In: Gregory, G.A., (Ed.) *Pediatric Anesthesia*, 3rd edn. pp. 773-792. New York: Churchill Livingstone Inc.

93. Harrison, M.G. and Roberts, G.J. (1998) Comprehensive dental treatment of healthy and chronically sick children under intubation general anaesthesia during a 5-year period. *Br.Dent.J.* **184**, 503-506.

94. Hartgraves, P.M. and Primosch, R.E. (1994) An evaluation of oral and nasal midazolam for pediatric dental sedation. *ASDC.J Dent Child* **61**, 175-181.

95. Hempenstall, P.D. and de Plater, R.M. (1991) Minimal morbidity in outpatients undergoing oral surgical procedures under general anaesthesia in the dental surgery. *Aust.Dent.J.* **36**, 102-108.

96. Henderson, J.A. (1991) Ambulatory Surgery: Past, Present, and Future. In: Wetchler, B.V., (Ed.) *Anesthesia for Ambulatory Surgery*, 2nd edn. pp. 1-27. Philadelphia: J.B. Lippincott Company.

97. Holland, R. (1987) Anaesthetic mortality in New South Wales. *Br.J Anaesth.* **59**, 834-841.

98. Holt, R.D., Chidiac, R.H. and Rule, D.C. (1991) Dental treatment for children under general anaesthesia in day care facilities at a London dental hospital. *Br.Dent.J.* **170**, 262-266.

99. Holt, R.D., Rule, D.C., Davenport, E.S. and Fung, D.E. (1992) The use of general anaesthesia for tooth extraction in children in London: a multi-centre study [see comments]. *Br.Dent.J.* **173**, 333-339.

100. Houck, W.R. and Ripa, L.W. (1971) Vomiting frequency in children administered nitrous oxide-oxygen in analgesic doses. *ASDC.J.Dent.Child* **28**, 404-406.

101. Houpt, M.I. (1993) Project USAP.The use of sedative agents in pediatric dentistry. *Pediatr.Dent* **15**, 36-40.

102. Houpt, M.I., Kupietzky, A., Tofsky, N.S. and Koenigsberg, S.R. (1996) Effects of nitrous oxide on diazepam sedation of young children. *Pediatr.Dent* **18**, 236-241.

103. Jantzen, J.P. and Diehl, P. (1991) Fundamentals and aplications in anesthesia. *Anaesthesist* **40**, 251

104. Jastak, J.T. (1992) Discussion: Morbidity and mortality from pharmacosedation and general anaesthesia in the dental office. *J.Oral Maxillofac.Surg.* **50**, 698

105. Johnston, T. and Brearley Messer, L. (1994) Nursing caries: Literature review and report of a case managed under local anaesthesia. *Aust.Dent.J.* **39**, 373-381.

106. Jorgensen, N.B. and Hayden, J. (1965) Complications from local anesthesia. *Dent Clin.North Am* 591-599.

107. Jorgensen, N.B. and Leffingwell, F.E. (1953) Premedication in dentistry. *J.Southern Calif.Dent.Assoc.* **21**, 1

108. Kamp, A.A. (1991) Well-baby dental examinations: A survey of preschool children's oral health. *Pediatr.Dent.* **13** , 86-90.

109. Karl, H.W., Swedlow, M.D. and Lee, K.W. (1983) Epinephrine-halothane interactions in children. *Anesthesiology* **58**, 142

110. Kataria, B., Epstein, R., Bailey, A., Schmitz, M., Backus, W.W., Schoeck, D., Hackl, W., Govaerts, M.J. , Rouge, J.C., Kern, C., Van, A.K., Hatch and DJ (1996) A comparison of sevoflurane to halothane in paediatric surgical patients: results of a multicentre international study. *Paediatr.Anaesth.* **6**, 283-292.

111. Keniry, A.J. (1974) An assessment of child patients requiring general anesthesia. *ASDC.J.Dent.Child* **41**, 194-200.

112. Kilpatrick, N.M. (1993) Durability of restorations in primary molars. *J Dent* **21**, 67-73.

113. Kilpatrick, N.M., Scott, J. and Robinson, S. (1998) Child protection: a survey of experience and knowledge within the dental profession of New South Wales, Australia. Unpublished.

114. Klein, A. (1991) Behavior management issues for pediatric patients. *J.Am.Dent.Assoc.* **122**, 70-72.

115. Korttila, K. (1995) Recovery from outpatient anaesthesia. Factors affecting outcome . *Anaesthesia* **50 (Supplement)**, 22-28.

116. Krafft, T.C., Kramer, N., Kunzelmann, K.H. and Hickel, R. (1993) Experience with midazolam as sedative in the dental treatment of uncooperative children. *ASDC.J.Dent.Child* **60**, 295-299.

117. Krippaehne, J.A. and Montgomery, M.T. (1992) Morbidity and mortality from pharmacosedation and general anesthesia in the dental office. *J.Oral Maxillofac.Surg.* **50**, 691-698.

118. Kupietzky, A., Holan, G. and Shapira, J. (1996) Intranasal midazolam better at effecting amnesia after sedation than oral hydroxyzine: a pilot study. *Pediatr.Dent* **18**, 32-34.

119. Kupietzky, A. and Houpt, M.I. (1993) Midazolam: a review of its use for conscious sedation of children. *Pediatr.Dent.* **15**, 237-241.

120. Leader (1991) Reprieve for dental general anaesthesia. *Br.Dent J* **170**, 43-43.

121. Leagault, J.V., Diner, M.H. and Auger, R. (1972) Dental treatment of children in a general anaesthesia clinic: review of 300 cases. *J Can.Dent Assoc.* **38**, 221-224.

122. Levitas, T.C. (1974) HOME-Hand Over Mouth Excercise. *J.Dent.Child* **41**, 78-82.

123. Levy, E. (1981) Iatrogenic subcutaneous emphysema during dental anesthesia: report of two cases. *ASDC.J.Dent.Child* **48**, 272-274.

124. Lisagor, M.S. (1978) The role of the pedodontist in the multiple-procedure approach to general anesthesia for children: report of four cases. *ASDC.J.Dent.Child* **45**, 465-468.

125. Lowey, M.N. and Halfpenny, W. (1993) Observations on the use of rectally administered diazepam for sedating children before treatment of maxillofacial injuries: report of nine cases. *Int J Paediatr.Dent* **3**, 89-93.

126. Lytle, J.J. and Yoon, C. (1980) 1978 Anaesthesia morbidity and mortality survey: Southern California Society of Oral and Maxillofacial Surgeons. *J.Oral Surg.* **38**, 814-819.

127. Major, E., Winder, M., Brook, A.H. and Berman, D.S. (1981) An evaluation of nitrous oxide in the dental treatment of anxious children. A physiological and clinical study. *Br.Dent.J.* **151**, 186-191.

128. Malamed, S.F. (1995a) General Anaesthesia: Armamentarium, drugs and techniques. In: Malamed, S.F., (Ed.) *Sedation. A guide to patient management.*, 3rd edn. pp. 471-494. St. Louis: Mosby]

129. Malamed, S.F. (1995b) Inhalation sedation: historical perspective. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 183-197. St. Louis: Mosby]

130. Malamed, S.F. (1995c) Inhalation sedation: rationale. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 198-207. St Louis: C.V. Mosby.

131. Malamed, S.F. (1995d) Intravenous sedation: historical perspective. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 307-310. St. Louis: C.V. Mosby.

132. Malamed, S.F. (1995e) Intravenous sedation: rationale. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 311-317. St. Louis: C.V. Mosby.

133. Malamed, S.F. (1995f) Monitoring. In: Malamed, S.F., (Ed.) *Sedation. A guide to patient management.*, 3rd edn. pp. 63-90. St. Louis: C.V. Mosby.

134. Malamed, S.F. (1995g) Pharmacology, anatomy, and physiology. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 208-221. St. Louis: C.V. Mosby.

135. Malamed, S.F. (1995h) Rectal sedation. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 131-137. St. Louis: C.V. Mosby.

136. Malamed, S.F. (1995i) Sublingual, transdermal, and intranasal sedation. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 138-145. St. Louis: C.V. Mosby.

137. Malamed, S.F. (1995j) The Pediatric Patient. In: Malamed, S.F., (Ed.) *Sedation. A Guide to Patient Management*, 3rd edn. pp. 553-572. St. Louis: C.V. Mosby.

138. Mansson, U. and Schroder, U. (1996) Treatment of children under general anaesthesia. A two year follow up. *European Academy Of Paediatric Dentistry* **3rd Congress**, 51-51.(Abstract)

139. Manton, D.J. and Brearley Messer, L. (1995) Pit and fissure sealants: Another major cornerstone in preventive dentistry. *Aust.Dent J* **40**, 22-29.

140. Mason, C., Holt, R.D. and Rule, D.C. (1995) The changing pattern of day-care treatment for children in a London dental teaching hospital. *Br.Dent.J.* **179**, 136-140.

141. McCann, W., Wilson, S., Larsen, P. and Stehle, B. (1996) The effects of nitrous oxide on behavior and physiological parameters during conscious sedation with a moderate dose of chloral hydrate and hydroxyzine. *Pediatr.Dent.* **18**, 35-41.

142. McCormick, A.S. and Spargo, P.M. (1996) Parents in the anaesthetic room: a questionnaire survey of departments of anaesthesia. *Paediatr.Anaesth.* **6**, 183-186.

143. McDonald, P.J. (1983) Outpatient oral surgery. *Aust.Dent.J.* **28**, 286-291.

144. McKay, W.P. and Noble, W.H. (1988) Critical incidents detected by pulse oximetry during anesthesia. *Can.J.Anaesth.* **35**, 265

145. McKnight Hanes, C., Myers, D.R. and Davis, H.C. (1994) Dentists' perceptions of selected characteristics of their child patients. *Pediatr.Dent* **16**, 268-271.

146. McKnight Hanes, C., Myers, D.R., Dushku, J.C. and Davis, H.C. (1993) The use of behavior management techniques by dentists across practitioner type, age, and geographic region. *Pediatr.Dent.* **15**, 267-271.

147. McLaughlin, W., Broomhead, L. and Hill, C.M. (1987) A 25-year review of general anaesthesia at the Leeds Dental Hospital. *Br.Dent.J.* **163**, 317-320.

148. Meechan, J.G. (1997) Local Anaesthesia for Children. In: Welbury, R.R., (Ed.) *Paediatric Dentistry*, 1st edn. pp. 77-92. Oxford: Oxford Medical Publications.

149. Messer, L.B. and Levering, N.J. (1988) The durability of primary molar restorations: II. Observations and predictions of success of stainless steel crowns. *Pediatr.Dent* **10**, 81-85.

150. Milgrom, P., Weinstein, P., Golletz, D., Leroux, B. and Domoto, P. (1994) Pain management in school-aged children by private and public clinic practice dentists. *Pediatr.Dent.* **16**, 294-300.

151. Miller, J.R., Redish, C.H., Fisch, C. and Oehler, R.C. (1970) Factors in arrhythmia during dental outpatient general anesthesia. *Anesth.Analg.* **49**, 701-706.

152. Milne, B., Katz, H. and Rosales, J. (1982) Subcutaneous surgical emphysema complicating dental anesthesia. *Can.Anaesth.Soc.J* **29**, 71-73.

153. Mitchell, L., Murray, J.J. and Ryder, W. (1985) Management of the handicapped and the anxious child: a retrospective study of dental treatment carried out under general anaesthesia. *J.Paediatr.Dent.* **1**, 9-14.

154. Moore, P.A., Acs, G. and Hargreaves, J.A. (1985) Post-extraction pain relief in children: a clinical trial of liquid analgesics. *International Journal Of Clinical Pharmacology Therapy and Toxicology* **23**, 573-577.

155. Moore, R., Miller, M.L., Weinstein, P., Dworkin, S.F. and Liou, H.H. (1986) Cultural perceptions of pain and pain coping among patients and dentists. *Community.Dent Oral Epidemiol.* **14**, 327-333.

156. Morrow, J.W., Seale, N.S., Berry, C.W. and Love, W.D. (1986) Incidence of temperature elevations after a full mouth dental rehabilitation under general anesthesia. *ASDC.J.Dent.Child* **53**, 420-424.

157. Motoyama, E.K. (1990a) Special characteristics of pediatric anesthesia. In: Motoyama, E.K. and Davis, P.J., (Eds.) *Smith's anesthesia for infants and children.*, 5th edn. pp. 3-10. St. Louis: C.V. Mosby.

158. Motoyama, E.K. and Davis, P.J. (1990b) *Smith's anesthesia for infants and children*, 5th edn. St Louis, Missouri: C.V. Mosby.

159. Muir, V.M., Leonard, M. and Haddaway, E. (1976) Morbidity following dental extraction. A comparative survey of local analgesia and general anaesthesia. *Anaesthesia* **31**, 171-180.

160. Murray, J.J. (1993) General anesthesia and children's dental health: present trends and future needs. *Anesth.Pain Control.Dent.* **2**, 209-216.

161. Murray, J.J. and Niven, N. (1992) The child as a dental patient. *Curr.Opin.Dent.* **2**, 59-65.

162. Murtomaa, H., Milgrom, P., Weinstein, P. and Vuopio, T. (1996) Dentists' perceptions and management of pain experienced by children during treatment: a survey of groups of dentists in the USA and Finland. *Int.J.Paediatr.Dent.* **6**, 25-30.

163. Nafiz, M.M. (1976) Nasal intubation in complete oral rehabilitation: a survey of eighty cases. *J.Dent.Child* **43**, 25-27.

164. Nathan, J.E. (1989) Management of the difficult child: a survey of pediatric dentists' use of restraints, sedation and general anesthesia. *J.Dent.Child* **56**, 293-301.

165. Nathan, J.E., Venham, L.L., West, M.S. and Werboff, J. (1988) The effects of nitrous oxide on anxious young pediatric patients across sequential visits: a double-blind study. *ASDC.J.Dent.Child* **55**, 220-230.

166. Nicoll, J.H. (1909) The surgery of infancy. *Br.Med.J.* **2**, 753-754.

167. Nkansah, P.J., Haas, D.A. and Saso, M.A. (1997) Mortality incidence in outpatient anesthesia for dentistry in Ontario. *Oral Surg.Oral Med.Oral Pathol Oral Radiol.Endod.* **83**, 646-651.

168. NSW Dental Health Branch (1997) SOKS- Save Our Kids Smiles. *NSW Dental Health Branch Newsletter* **April** Sydney, NSW: NSW Department of Health.

169. Nunn, J.H., Davidson, G., Gordon, P.H. and Storrs, J. (1995) A retrospective review of a service to provide comprehensive dental care under general anesthesia. *Spec.Care Dentist.* **15**, 97-101.

170. O'Brien, H.D. and Suthers, W.D. (1983) Conservative dentistry for children under general anaesthesia in the dental surgery. *Aust.Dent.J.* **28**, 73-78.

171. O'Connell, J.E., Stevenson, D.S. and Stokes, M.A. (1996) Pathological changes associated with short-term nasal intubation. *Anaesthesia* **51**, 347-350.

172. O'Sullivan, E.A. and Curzon, M.E. (1991) The efficacy of comprehensive dental care for children under general anesthesia [published erratum appears in Br Dent J 1991 Sep 7;171(5):122] [see comments]. *Br.Dent.J.* **171**, 56-58.

173. Oei-Lim, L.B., Vermeulen-Cranch, D.M. and Bouvy-Berends, E.C. (1991) Conscious sedation with propofol in dentistry. *Br.Dent J* **170**, 340-342.

174. Ogg, T.W. (1972) An assessment of postoperative outpatient cases. *Br.Med.J.* **4**, 573-576.

175. Ogg, T.W., MacDonald, I.A., Jennings, R.A. and Morrison, C.G. (1983) Day case dental anaesthesia. Evaluation of three methods of anaesthesia. *Br.Dent.J.* **155**, 14-17.

176. Oh, T.H. and Davis, P.J. (1990) Pediatric Outpatient Anesthesia. In: Motoyama, E.K. and Davis, P.J., (Eds.) *Anesthesia for Infants and Children* , 5th edn. pp. 681-687. St. Louis: C.V. Mosby.

177. Okamoto, G.U., Duperon, D.F. and Jedrychowski, J.R. (1992) Clinical evaluation of the effects of ketamine sedation on pediatric dental patients. *J Clin.Pediatr.Dent* **16**, 253-257.

178. Olsson, G.L. (1995) Inhalational anaesthesia at the extremes of age:paediatric anaesthesia. *Anaesthesia* **50 (Supplement)**, 34-36.

179. Olsson, G.L. and Hallen, B. (1984) Laryngospasm during anaesthesia. A computer-aided incidence study in136,929 patients. *Acta Anaesthesiol.Scand.* **28**, 567-575.

180. Owens, W.D., Felts, J.A. and Spitznagel, E.L.J. (1978) ASA physical status classifications: a study of consistency of ratings. *Anesthesiology* **49**, 239-243.

181. Palazzo, M.G. and Strunin, L. (1984) Anaesthesia and emesis. I: aetiology. *Can.Anaesth.Soc.J.* **31**, 178-187.

182. Patel, R.L. and Hannallah, R.S. (1988) Anesthetic complications following pediatric ambulatory surgery: a 3-year study. *Anesthesiology* **69**, 1009-1012.

183. Patel, S.S. and Goa, K.L. (1996) Sevoflurane. A review of its pharmacodynamic and pharmacokinetic properties and its clinical use in general anaesthesia. *Drugs* **51**, 658-700.

184. Patterson, A.F. and Weidenhofer, R.N. Dental Health Unit, (Ed.) (1993) A study of the dental health of primary school children in the local government areas of the Blue Mountains and Hawkesbury, New South Wales, 1993. Sydney: NSW Health Department.

185. Payne, K., Mattheyse, F.J., Liebenberg, D. and Dawes, T. (1989) Pharmacokinetics of midazolam in pediatric patients. *Eur.J.Clin.Pharmacol.* **37**, 267-272.

186. Persliden, B. and Magnusson, B.O. (1980) Medical complications of dental treatment under general anaesthesia in children. *Swed.Dent.J.* **4**, 155-159.

187. Pinkham, J.R. (1994) The Practical Importance of Paediatric Dentistry. In: Pinkham, J.R., Casamassimo, P.S., McTigue, D.J., Fields, H.W. and Nowak, A., (Eds.) *Paediatric Dentistry. Infancy Through Adolescence*, 2nd edn. pp. 2-11. Philadelphia: W.B. Saunders Company.

188. Plowman, P.E., Thomas, W.J. and Thurlow, A.C. (1974) Cardiac dysrhythmias during anesthesia for oral surgery. *Anaesthesia* **29**, 571-575.

189. Podesta, J.R. and Watt, R.G. (1996) A quality assurance review of the patient referral process and user satisfaction of outpatient general anaesthesia services for dental treatment. *Community.Dent.Health* **13**, 228-231.

190. Poswillo, D.E. (1990) General anaesthesia, sedation and resuscitation in dentistry. Report of an expert working party. pp.1-41. London: Standing Dental Advisory Committee.

191. Puttick, N. and Rosen, M. (1988) Propofol induction and maintenance with nitrous oxide in paediatric outpatient dental anaesthesia. A comparison with thiopentone-nitrous oxide-halothane. *Anaesthesia* **43**, 646-649.

192. Rainey, J.B. and Ruckley, C.V. (1979) Work of a day-bed unit 1972-8. *Br.Med.J.* **2**, 714-717.

193. Rey, E., Delaunay, L. and Pons, G. (1991) Pharmacokinetics of midazolam in children: comparative study of intranasal and intravenous administration. *Eur.J.Clin.Pharmacol.* **41**, 355-357.

194. Riordan, P.J. (1991) Dental caries and fluoride exposure in Western Australia. *J Dent Res* **70**, 1029-1034.

195. Ripa, L.W. (1988) Nursing caries: a comprehensive review. *Pediatr.Dent.* **10**, 268-282.

196. Roberts, G.J. (1990a) Inhalation sedation (relative analgesia) with oxygen/nitrous oxide gas mixtures: 1. Principles. *Dent.Update.* **17**, 139-146.

197. Roberts, G.J. (1990b) Inhalation sedation (relative analgesia) with oxygen/nitrous oxide gas mixtures: 2. Practical techniques [published erratum appears in Dent Update 1990 Sep;17(7):303]. *Dent.Update.* **17**, 190-196.

198. Roberts, G.J. (1997) Management of pain and anxiety. In: Welbury, R.R., (Ed.) *Paediatric Dentistry*, 1st edn. pp. 51-74. Oxford: Oxford University Press.

199. Roberts, J.F. and Sherriff, M. (1990) The fate and survival of amalgam and preformed crown molar restorations placed in a specialist paediatric dental practice [published erratum appears in Br Dent J 1990 Nov 10;169(9):285]. *Br.Dent J* **169**, 237-244.

200. Robertson, J.R. and Ball, H.C. (1973) Dental treatment with general anaesthesia for handicapped patients. *Br.Dent.J.* **134**, 151-153.

201. Rodrigo, M.R. and Jonsson, E. (1989) Conscious sedation with propofol. *Br.Dent J* **166**, 75-80.

202. Roelofse, J.A., Stegmann, D.H., Hartshorne, J. and Joubert, J.J. (1990a) Paradoxical reactions to rectal midazolam as premedication in children. *Int.J Oral Maxillofac.Surg.* **19**, 2-6.

203. Roelofse, J.A., van der Bijl, P., Stegmann, D.H. and Hartshorne, J.E. (1990b) Preanesthetic medication with rectal midazolam in children undergoing dental extractions. *J Oral Maxillofac.Surg.* **48**, 791-797.

204. Roeters, J. and Burgersdijk, R. (1985) The need for general anaesthesia for the dental treatment of mentally handicapped patients: a follow up study. *J.Dent.Child* **52**, 344-346.

205. Rosenberg, M.B. and Campbell, R.L. (1991) Guidelines for intraoperative monitoring of dental patients undergoing conscious sedation, deep sedation, and general anesthesia. *Oral Surg.Oral Med.Oral Pathol Oral Radiol.Endod.* **71**, 2-8.

206. Rosenberg, M.B., Wunderlich, B.K. and Reynolds, R.N. (1979) Iatrogenic subcutaneous emphysema during dental anesthesia. *Anesthesiology* **51**, 80-81.

207. Rowley, M.P. and Brown, T.C. (1982) Postoperative vomiting in children. *Anaesth.Intensive.Care* **10**, 309-313.

208. Rugg-Gunn, A.J., Carmichael, C.L. and Ferrell, R.S. (1988) Effect of fluoridation and secular trends in caries in 5-year-old children living in Newcastle and Northumberland. *Br.Dent J* **165**, 359-364.

209. Rule, D.C., Winter, G.B., Goldman, V. and Brookes, R.C. (1967) Restorative treatment for children under general anaesthesia: the treatment of apprehensive and handicapped children as clinic out-patients. *Br.Dent.J.* **123**, 480-484.

210. Ryder, W. and Townsend, D. (1974) Cardiac rhythm in dental anaesthesia: a comparison of five anaesthetic techniques. *Br.J.Anaesth.* **46**, 760-764.

211. Saint-Maurice, C., Landais, A., Delleur, M.M., Esteve, C., MacGee, K. and Murat, I. (1990) The use of midazolam in diagnostic and short surgical procedures in children. *Acta Anaesthesiol.Scand.Suppl.* **92**, 39-41.

212. Sams, D.R., Thornton, J.B. and Wright, J.T. (1992) The assessment of two oral sedation drug regimens in pediatric dental patients. *ASDC.J.Dent.Child* **59**, 306-312.

213. Schieber, R.A. (1990) Cardiovascular physiology in infants and children. In: Motoyama, E.K. and Davis, P.J., (Eds.) *Smith's Anesthesia for Infants and Children*, 5th edn. pp. 77-104. St louis: C.V. Mosby.

214. Schreiner, M.S., Nicolson, N.C., Martin, T. and Whitney, L. (1992) Should children drink before discharge from day surgery? *Anesthesiology* **76**, 528-533.

215. Schwartz, S., Bevan, J.C., Roberts, G. and Dean, D.M. (1992) Midazolam sedation and local anaesthesia compared with general anaesthesia for paediatric outpatient dental surgery. *Paediatr.Anaesth.* **2**, 309-315.

216. Shapira, J., Holan, G., Guelmann, M. and Cahan, S. (1992) Evaluation of the effect of nitrous oxide and hydroxyzine in controlling the behavior of the pediatric dental patient. *Pediatr.Dent* **14**, 167-170.

217. Sharaf, A.A.T. (1997) Evaluation of mandibular infiltration and block anesthesia in pediatric dentistry. *J Dent Child* **64**, 276-281.

218. Shaw, A.J., Meechan, J.G., Kilpatrick, N.M. and Welbury, R.R. (1996a) The use of inhalation sedation and local anaesthesia instead of general anaesthesia for extractions and minor oral surgery in children: a prospective study. *Int.J.Paediatr.Dent.* **6**, 7-11.

219. Shaw, A.J. and Niven, N. (1996b) Theoretical concepts and practical applications of hypnosis in the treatment of children and adolescents with dental fear and anxiety. *Br.Dent J* **180**, 11-16.

220. Shaw, L. and Weatherill, S. (1996) Is general anaesthesia for orthodontic extractions in children necessary? *Br.Dent.J.* **181**, 6-7.

221. Silver, T., Wilson, C. and Webb, M. (1994) Evaluation of two dosages of oral midazolam as a conscious sedation for physically and neurologically compromised pediatric dental patients. *Pediatr.Dent* **16**, 350-359.

222. Slade, G.D., Davies, M.J., Spencer, A.J. and Stewart, J.F. (1995) Associations between exposure to fluoridated drinking water and dental caries experience among children in two Australian states [see comments]. *J Public Health Dent* **55**, 218-228.

223. Slade, G.D., Spencer, A.J., Davies, M.J. and Stewart, J.F. (1996a) Caries experience among children in fluoridated Townsville and unfluoridated Brisbane [see comments]. *Aust.N.Z.J Public Health* **20**, 623-629.

224. Slade, G.D., Spencer, A.J., Davies, M.J. and Stewart, J.F. (1996b) Influence of exposure to fluoridated water on socioeconomic inequalities in children's caries experience. *Community.Dent Oral Epidemiol.* **24**, 89-100.

225. Smallridge, J.A., Al Ghanim, N. and Holt, R.D. (1990) The use of general anaesthesia for tooth extraction for child out-patients at a London dental hospital [see comments]. *Br.Dent.J.* **168**, 438-440.

226. Smith, B.L. and Young, P.N. (1976) Day stay anaesthesia. A follow-up of day patients undergoing dental operations under general anaesthesia with tracheal intubation. *Anaesthesia* **31**, 181-189.

227. Smith, R.M. (1980) *Anesthesia for infants and children,* 4th edn. St. Louis: CV Mosby.

228. Smith, R.M. (1990) Anesthesia for Dentistry. In: Motoyama, E.K. and Davis, P.J., (Eds.) *Anesthesia for Infants and Children,* 5th edn. pp. 675-680. St. Louis: C.V. Mosby.

229. Soliman, I.E., Broadman, L.M., Hannallah, R.S. and McGill, W.A. (1988) Comparison of the analgesic effects of EMLA (eutectic mixture of local anesthetics) to intradermal lidocaine infiltration prior to venous cannulation in unpremedicated children. *Anesthesiology* **68**, 804-806.

230. Spencer, A.J., Davies, M.J., Slade, G. and Brennan, D. (1994) Caries prevalence in Australasia . *Int.Dent.J.* **44**, 415-423.

231. Spencer, A.J., Slade, G.D. and Davies, M. (1996) Water fluoridation in Australia. *Community.Dent Health* **13 Suppl 2**, 27-37.

232. St.Clair, T. (1995) Informed consent in pediatric dentistry: a comprehensive overview. *Pediatr.Dent* **17**, 90-97.

233. Steward, D.J. (1975) Outpatient pediatric anesthesia. *Anesthesiology* **43**, 268-276.

234. Szuster, F.S. and Spencer, A.J. The Australian Institute Of Health and Welfare and The University of Adelaide, (Eds.) (1997) Dental therapist labourforce Australia, 1996. 13, p.15 Adelaide: The University Of Adelaide.

235. Tarjan, I., Mickecz, G. and Denes, J. (1990) General anaesthesia of outpatients in paedodontics. *J.Int.Assoc.Dent.Child.* **20**, 59-61.

236. Thomson, W.M. (1993) Ethnicity and child dental health status in the Manawatu-Wanganui Area Health Board. *N.Z.Dent.J.* **89**, 12-14.

237. Thomson, W.M. (1994) Day-stay treatment for dental caries at a New Zealand hospital dental unit: a 5-year retrospective audit. *N.Z.Dent.J.* **90**, 139-142.

238. Thurlow, A.C. (1972) Cardiac dysrhythmias in outpatient dental anaesthesia in children. The effect of prophylactic intravenous atropine. *Anaesthesia* **27**, 429-435.

239. Tiret, L., Nivoche, Y., Hatton, F., Desmonts, J.M. and Vourc'h, G. (1988) Complications related to anaesthesia in infants and children. A prospective survey of 40240 anaesthetics. *Br.J Anaesth.* **61**, 263-269.

240. Tolksdorf, W. and Eicj, C. (1991) Rectal, oral and nasal premedication using midazolam in children aged 1-6 years. A comparative clinical study. *Anaesthesist* **40**, 661.

241. Tomlin, P.J. (1974) Death in outpatient dental anaesthetic practice. *Anaesthesia* **29**, 551-570.

242. Trapp, L.D. (1982) Sedation of children for dental treatment. *Pediatr.Dent.* **4**, 164.

243. Trapp, L.D. (1987) Special considerations in pedodontic anesthesia. *Dent.Clin.North Am.* **31**, 131-138.

244. Tsinidou, K.G., Curzon, M.E. and Sapsford, D.J. (1992) A study to compare the effectiveness of temazepam and a chloral hydrate/hydroxyzine combination in sedating paediatric dental patients. *Int J Paediatr.Dent* **2**, 163-169.

245. Valtonen, M., Iisalo, E., Kanto, J. and Tikkanen, J. (1988) Comparison between propofol and thiopentone for induction of anaesthesia in children. *Anaesthesia* **43**, 696-699.

246. van der Bijl, P., Roelofse, J.A. and Stander, I.A. (1991) Rectal ketamine and midazolam for premedication in pediatric dentistry. *J Oral Maxillofac.Surg.* **49**, 1050-1054.

247. Varpio, M. and Wellfelt, B. (1991) Some characteristics of children with dental behaviour problems. Five-year follow-up of pedodontic treatment. *Swed.Dent.J.* **15**, 85-93.

248. Venham, L. and Quatrocelli, S. (1977) The young child's response to repeated dental procedures. *J Dent Res* **56**, 734-738.

249. Ventura, E., Levy, E., Friedman, M. and Gat, H. (1981) General anesthesia for complete oral rehabilitation in children. *ASDC.J.Dent.Child* **48**, 33-35.

250. Vermeulen, M., Vinckier, F. and Vandenbroucke, J. (1991) Dental general anesthesia: clinical characteristics of 933 patients. *ASDC.J.Dent.Child* **58**, 27-30.

251. Vickers, P. and Goss, A.N. (1983) Day-stay oral surgery. *Aust.Dent.J.* **28**, 135-138.

252. Videroni, W., Sternberg, G.S. and Davies, G.N. (1976) Effect on caries experience of lifetime residents after 10 years of fluoridation in Townsville, Australia. *Community.Dent Oral Epidemiol.* **4**, 248-253.

253. Warden, J.C. and Horan, B.F. (1996) Deaths attributed to anaesthesia in New South Wales, 1984- 1990. *Anaesth.Intensive.Care* **24**, 66-73.

254. Warner, M.A., Shields, S.E. and Chute, C.G. (1993) Major morbidity and mortality within 1 month of ambulatory surgery and anesthesia. *J.Am.Med.Assoc.* **270**, 1437-1441.

255. Watson, A.O. (1979) Treatment of cerebral palsied patients. A report on 33 years of treatment from 1946 to 1978. *Aust.Dent.J.* **24**, 290-300.

256. Weinstein, P., Getz, T., Ratener, P. and Domoto, P. (1982) The effect of dentists' behaviors on fear-related behaviors in children. *J.Am.Dent.Assoc.* **104**, 132-138.

257. Weinstein, P. and Nathan, J.E. (1988) The challange of fearful and phobic children. *Dent.Clin.North Am.* **32**, 667-692.

258. Welbury, R.R., Walls, A.W., Murray, J.J. and McCabe, J.F. (1991) The 5-year results of a clinical trial comparing a glass polyalkenoate (ionomer) cement restoration with an amalgam restoration [see comments]. *Br.Dent J* **170**, 177-181.

259. Whitehead, B.G., Durr, D.P., Adair, S.M. and Proskin, H.M. (1988) Monitoring of sedated pediatric dental patients. *ASDC.J.Dent.Child* **55**, 329-333.

260. Whitehead, F.I.H. (1971) Minor oral surgery in a dental hospital day-stay unit. *Br.Dent.J.* **130**, 69-71.

261. Widmer, R.P. and Mekertichian, K. (1996) A contemporary approach to the art and science of caries risk assessment. *Ann.Roy.Australas.Coll.Dent.Surg.* **13**, 119-126.

262. Wilton, N.C.T., Leigh, J., Rosen, D.R. and Pandit, U.A. (1988) Preanesthetic sedation of preschool children using intranasal midazolam. *Anesthesiology* **69**, 972-975.

263. Wong, F.S.L., Fearne, J.M. and Brook, A.H. (1997) Planning future general anaesthetic services in paediatric dentistry on the basis of evidence: an analysis of children treated in the Day Stay Centre at the Royal Hospitals NHS Trust, London, between 1985-95. *Int Dent J* **47**, 285-292.

264. Working Party Report (1975) The operator/anaesthetist in dentistry. *Br.Dent.J.* 355-357.

265. Working Party Report of ANZCA Horan, B.F., (Ed.) (1998) Anaesthesia related mortality in Australia: 1991-1993. pp.1-28. Victoria, Australia: Capitol Press.

266. Wright, F.A., Giebartowski, J.E. and McMurray, N.E. (1991a) A national survey of dentists' management of children with anxiety or behaviour problems. *Aust.Dent J* **36**, 378-383.

267. Wright, F.A., McMurray, N.E. and Giebartowski, J. (1991b) Strategies used by dentists in Victoria, Australia, to manage children with anxiety or behavior problems. *ASDC.J Dent Child* **58**, 223-228.

268. Wyne, A.H., Spencer, A.J. and Szuster, F.S. (1991) Prevalence and risk factors of Nursing caries in Adelaide pre-school children. *J Dent Res* **70**.

269. Yanase, H., Braham, R.L., Fukuta, O. and Kurosu, K. (1996) A study of the sedative effect of home-administered oral diazepam for the dental treatment of children. *Int.J Paediatr.Dent* **6**, 13-17.

270. Yee, K.F. and Davis, A.C. (1984) One year's experience in a new dental day-stay unit. *Anaesth.Intensive.Care* **12**, 131-136.

271. Yee, K.F., Holland, R.B., Carrick, A. and Vincent, S.J. (1985) Morbidity following day stay dental anaesthesia. *Aust.Dent.J.* **30**, 333-335.

272. Zeitlin, G.L. (1989) Possible decrease in mortality associated with anaesthesia. A comparison of two time periods in Massachusetts, USA. Closed Claims Study Committee. *Anaesthesia* **44**, 432-433.

LIST OF APPENDICES

Appendix No. 1: American Society of Anesthesiologists Classification

ASA I

There is no organic, physiological, biochemical, or psychiatric disturbance. The pathologic process for which operation is to be performed is localised and is not a systemic disturbance.

ASA II

Mild-to-moderate systemic disturbance caused either by the condition to be treated surgically or by other pathophysiological processes.

ASA III

Severe systemic disturbance or disease from whatever cause, even though it may not be possible to define the degree of disability with finality.

ASA IV

Indicative of the patient with severe systemic disorder already life-threatening, not always correctable by the operative procedure.

ASA V

A moribund patient not expected to survive 24 hours with or without operation.

ASA E

Emergency operation of any variety; *E* precedes the number indicating the patient's physical status (e. g., ASA E-III).

Appendix No. 2: Protocols for antibiotic prophylaxis against infective endocarditis

Procedures that require prophylaxis

- All dental procedures likely to induce bleeding.
- First-visit endodontic procedures.
- Endotracheal intubation.

Procedures that do not require prophylaxis

- Simple adjustment of orthodontic appliances.
- Restorations above the gingival margin.
- Endodontic procedures confined to the root canal after pulp extirpation.
- Injection of local intra-oral anaesthetic (except intraligamentary injections).
- Exfoliation of primary teeth.

Relative risk of procedures

It is considered that some procedures subject the patient to a higher level of risk of developing endocarditis than others. An open surgical procedure will produce a significantly greater bacteraemia than gingival scaling or placing a matrix band below the gingival margin. If the procedure is determined to put a potentially susceptible patient at higher risk the use of parenteral antibiotics should be considered.

Protocols for antibiotic prophylaxis

These protocols are based on those published by the Victorian Drug Usage Advisory Committee (1992) and recommended by the Australian Dental Association.

Protocols for susceptible patients

Non-penicillin-allergic patients able to take oral medications

	Amoxycillin
Children	50 mg/kg orally 1 hour before procedure
Adults	3.0 g

Penicillin-allergic patients

	Clindamycin
Children	10 mg/kg orally or intravenously followed by 5 mg/kg 6 hours later
Adults	600mg orally 1 hour before procedure followed by 300mg 6 hours after initial dose **or**

	Vancomycin
Children	20mg/kg infused over 1 hour before procedure
Adults	1.0 g infused over 1 hour before procedure

Susceptible patients under general anaesthetic

	Ampicillin or *amoxycillin*
Children	50mg/kg intravenously just before procedure followed by 25 mg/kg 6 hours later

Adults	1.0 g intravenously just before procedure or intramuscularly 30 min before procedure. Then 500mg intravenously, intramuscularly or orally, 6 hours after initial dose

Protocol for highly susceptible patients or high-risk procedures

Non-penicillin-allergic patients

Children	*Ampicillin* or *amoxycillin* 50mg/kg intravenously + *gentamycin* 2.5 mg/kg (up to 80 mg maximum) followed by *amoxycillin* 25 mg/kg 6 hours later
Adults	*Ampicillin* or *amoxycillin* 1.0g intravenously + *gentamycin* 1.5 mg/kg (up to 80 mg maximum) intravenously just before procedure or intramuscularly 30 minutes before procedure followed by *amoxycillin* 500mg 6 hours later

Penicillin-allergic patients

Children	*Vancomycin* 20mg/kg infused over 1 hour before procedure followed by *gentamycin* 2.5 mg/kg intravenously (up to 80 mg maximum) before procedure commences
Adults	*Vancomycin* 1.0g infused over 1 hour to end just prior to procedure, followed by *gentamycin* 1.5 mg/kg intravenously (up to 80 mg maximum) just before procedure commences

Total paediatric dose should not exceed total adult dose.

- It is always preferable to prescribe on a dose per kilogram basis.
- Paediatric doses should be calculated up to the adult dose.
- It is expected that some cases of endocarditis will occur, despite the use of optimal prophylaxis protocols.
- Good history taking is essential.
- If in doubt, consult relevant medical authorities.

Appendix No. 3: Guidelines for the care of patients recovering from anaesthesia. Review P4 (1995)

AUSTRALIAN AND NEW ZEALAND COLLEGE OF ANAESTHETISTS

A.C.N. 055 042 852

1. GENERAL PRINCIPLES

1.1 Recovery from anaesthesia should take place under supervision in an area designated for the purpose.

1.2 This area should be close to where the anaesthetic was administered.

1.3 The staff working in this area must be trained for their role and able to contact supervising medical staff promptly when the need arises.

1.4 In some situations (for example, paediatric hospitals) minor variations in these Guidelines may be appropriate.

2. THE RECOVERY AREA

2.1 Design Features

2.1.1 The area should be part of the operating or procedural suite. Access should be available to medical staff who are not in operating suite clothing, so that they may continue to supervise the patient's care. Provision should be made for rapid evacuation of patients from the area in an emergency.

2.1.2 It should have ventilation to operating theatre standards.

2.1.3 The space allocated per bed/trolley should be at least 9 square metres. There must be easy access to the patient's head.

2.1.4 The number of bed/trolley spaces must be sufficient for expected peak loads and there should be at least 1.5 spaces per operating room.

2.1.5 Each bed space must be provided with:

2.1.5.1 an oxygen outlet

2.1.5.2 a vacuum outlet complying with the current requirements of the relevant national Standards.

2.1.5.3 two General Power Outlets

2.1.5.4 lighting to allow accurate detection of cyanosis

2.1.5.5 emergency lighting

2.1.5.6 appropriate facilities for mounting and operating any necessary equipment and for the patient's chart.

2.1.6 Space must be provided for a nursing station, storage of drugs, of clean linen as well as a utility room.

2.1.7 There must be appropriate facilities for scrubbing up for procedures.

2.1.8 There should be a wall clock with a sweep second hand or analogue display clearly visible from each bed space.

2.1.9 Communication facilities should include:

2.1.9.1 an emergency call system to areas such as the Department of Anaesthesia.

2.1.9.2 a telephone and access to the Hospital paging system.

2.1.10 There should be easy access for portable X-Ray equipment with appropriate power outlets provided in the area. There should also be an X-Ray viewing box. An

emergency power supply should be available in the area.

2.1.11 An emergency power supply should be available in the area

3. EQUIPMENT AND DRUGS

3.1 Each bed space should be provided with:

3.1.1 oxygen flowmeter and patient oxygen delivery systems

3.1.2 suction equipment including a receiver, appropriate hand pieces and a range of suction catheters a pulse oximeter

3.1.4 a sphygmomanometer which may be automated and include cuffs suitable for all patients

3.1.5 a stethoscope

3.1.6 a means of measuring body temperature

3.2 Within the recovery area there must be:

3.2.1 a means of inflating the lungs with oxygen in a ratio of one per two bed spaces, but with a minimum of two such devices

3.2.2 airway management and intubation drugs and equipment

3.2.3 emergency and resuscitative drugs

3.2.4 a range of I.V. equipment and fluids and a means of warming those fluids

3.2.5 drugs for pain control

3.2.6 a range of syringes and needles

3.2.7 electrocardiographs with a minimum of I to 3 bed spaces.

3.3 There should be easy access to:

3.3.1 a 12 lead electrocardiograph

3.3.2 a monitor for measurement of direct arterial and venous pressures

3.3.3 a capnometer

3.3.4 a defibrillator

3.3.5 a neuromuscular function monitor

3.3.6 a bronchoscope with sucker and grasping forceps

3.3.7 a warming cupboard

3.3.8 a refrigerator for drugs and blood

3.3.9 a patient warming device

3.3.10 a procedure light

3.3.11 a simple surgical tray

3.3.12 blood gas and electrolyte measuring

3.3.13 diagnostic imaging services

3.4 The recovery trolley/bed must:

3.4.1 have a firm base and mattress

3.4.2 tilt from one or both ends both head up and head down at least 15 degrees

3.4.3 be easy to manoeuvre

3.4.4 have efficient and accessible brakes

3.4.5 provide for sitting the patient up

3.4.6 have secure side rails which must be able to be dropped below the base or be easily removed

3.4.7 have an I.V. pole

3.4.8 have provision for mounting monitoring equipment, patient ventilation equipment, oxygen cylinders, underwater seal drains and suction apparatus during transport of patients.

4. STAFFING

4.1 Staff trained in the care of patients recovering from anaesthesia must be present at all times.

4.2 A registered nurse trained in recovery area care should be in charge.

4.3 Trainee nurses and registered nurses who are not experienced in the care of patients

recovering from anaesthesia must be supervised.

4.4 The ratio of registered nurses to patients needs to be flexible so as to provide no less than one nurse to three patients, and one nurse to each patient who has not recovered protective reflexes or consciousness.

5. MANAGEMENT AND SUPERVISION

5.1 Written protocols for management should be established. The Director of Anaesthesia, or the Anaesthetist-in-Charge, should be responsible for the medical aspects of these policies.

5.2 A written routine for checking the equipment and drugs must be established.

5.3 Observations should be recorded at appropriate intervals and should include state of consciousness, oxygen saturation, respiratory rate, pulse rate, blood pressure and temperature.

5.4 All patients should remain until they are considered safe to be discharged from the recovery area according to established criteria.

5.5 The anaesthetist responsible for the patient should:

5.5.1 accompany the patient until transfer to recovery area staff is completed

5.5.2 provide written and verbal instructions to the recovery area staff

5.5.3 specify the type of apparatus and the flow rate to be used for oxygen therapy

5.5.4 remain in the vicinity until the patient is safe to be left in the care of recovery area staff

5.5.5 supervise the recovery period and authorise the patient's discharge from the recovery area. It is recognised that in some circumstances it may be necessary for the anaesthetist previously responsible for the patient to delegate these duties to a trained recovery area nurse or to another anaesthetist who should be fully informed of the clinical state of the patient.

5.6 The practitioner responsible for the patient's overall care should be available to consult with the anaesthetist should the need arise in the recovery period and, where appropriate, to authorise the discharge of the patient.

This policy document has been prepared having regard to general circumstances, and it is the responsibility of the practitioner to have express regard to the particular circumstances of each case, and the application of this policy document in each case.

Policy documents are reviewed from time to time, and it is the responsibility of the practitioner to ensure that the practitioner has obtained the current version. Policy documents have been prepared having regard to the information available at the time of their preparation, and the practitioner should therefore have regard to any information, research or material which may have been published or become available subsequently.

Whilst the College endeavours to ensure that policy documents are as current as possible at the time of their preparation, it takes no responsibility for matters arising from changed circumstances or information or material which may have become available subsequently.

Promulgated: 1989

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Appendix No. 4: Guidelines for the perioperative care of patients selected for day care surgery. Review P15 (1995)

AUSTRALIAN AND NEW ZEALAND COLLEGE OF ANAESTHETISTS

A.C.N. 055 042 852

Day Care Surgery means that the patient will ordinarily be discharged from the hospital or unit later on the day of the procedure. Anaesthesia for the procedure may require general, regional or sedative techniques.

SELECTION GUIDELINES

1. Procedures suitable for day care surgery must entail:

1.1 A minimal risk of post operative haemorrhage.

1.2 A minimal risk of post operative airway compromise.

1.3 Post operative pain controllable by outpatient management techniques.

1.4 No special post operative nursing requirements.

1.5 A rapid return to normal fluid and food intake.

2. Patient requirements for day care surgery include:

2.1 A willingness to have the procedure performed together with an understanding of the process and ability to follow discharge instructions.

2.2 Physical status of ASA I or II. Medically stable ASA III or IV patients may be accepted for day care surgery following consultation with the anaesthetist concerned.

2.3 Normal term infants of over three months of age or ax-premature infants (less than

37 weeks gestation) of more than 60 weeks post-conceptual age. Prior consultation with the anaesthetist is essential.

In all cases, the ultimate decision as to the suitability of a patient for day care surgery is that of the anaesthetist. The decision as to the type of anaesthesia must remain in the province of the anaesthetist and will be based on surgical requirements, patient considerations, the experience of the anaesthetist and the facilities of the day care surgical unit.

3. Social requirements for day care surgery include:

3.1 A responsible person able to transport the patient home in a suitable vehicle.

3.2 A responsible person at home for at least the first night after discharge from the unit.

A responsible person is an adult who understands the instructions given to them and is physically and mentally able to make decisions for the patient's welfare when appropriate.

4. Patient Preparation

4.1 ANZCA Policy Document P7 (1992) 'The Pre-Anaesthetic Consultation' describes the essential nature of this consultation for all patients who are to receive anaesthesia.

4.2 ANZCA Policy Documents P22 (1990) 'Statement on Patients' Rights and Responsibilities' and P26 (1994) 'Guidelines on Providing Information about Anaesthesia' are both relevant to preparation for day stay surgery.

4.3 Patient assessment can be assisted by:

4.3.1 A standardised anaesthesia questionnaire.

4.3.2 Preliminary nurse assessment.

4.3.3 Prior surgical referral in cases of doubt as to suitability for day care surgery.

4.4 Patient information in an understandable written format must include:

4.4.1 General information about the processes followed in the day care unit.

4.4.2 Instructions for fasting according to the following guidelines:

4.4.2.1 Limited solid food may be taken up to six hours prior to anaesthesia.

4.4.2.2 Unsweetened clear fluids totaling not more than 200 ml per hour may be taken up to three hours prior to anaesthesia.

4.4.2.3 Only medications or water ordered by the anaesthetist should be taken less than three hours prior to anaesthesia.

4.4.2.4 An Hz-receptor antagonist should be considered for patients with an increased risk of gastric regurgitation.

These guidelines may be modified in some patients, particularly infants and small children, on advice from the anaesthetist.

5. Recovery from anaesthesia

5.1 ANZCA Policy Document P4 (1995) 'Guidelines for the Care of Patients Recovering from Anaesthesia in the Recovery Area' establishes requirements for the facilities and staffing of recovery areas. This document is fully applicable to day care units.

5.2 An area must be provided with comfortable reclining seating for patients to complete recovery prior to discharge home. This area must be adequately supervised by nursing staff and should also have ready access to resuscitation equipment, including oxygen and suction equipment. Patients must not leave this area unaccompanied.

6. Discharge of the patient from the day care unit

The discharge area should have easy access to wheel chairs, a parking area and ambulance facilities so as to minimise walking for the post operative patient and to aid transfer of the patient to inpatient hospital care when this is necessary. The following criteria apply to patient discharge:

6.1 Stable vital signs for at least one hour.

6.2 Correct orientation as to time, place and relevant people.

6.3 Adequate pain control with oral analgesics.

6.4 Ability to dress and walk should be equivalent to preoperative standards.

6.5 Minimal nausea, vomiting or dizziness.

6.6 May tolerate oral fluids without vomiting.

6.7 Minimal bleeding or wound drainage.

6.8 Has passed urine. This is particularly important after central neural blockade or pelvic surgery.

6.9 A responsible adult to take the patient home. For children, and in other situations where necessary, there should be an adult escort as well as the vehicle driver.

6.10 Discharge should be authorised by surgeon and anaesthetist or their designated alternative after the above criteria have been satisfied.

6.11 Written and verbal instructions for all relevant aspects of post anaesthetic and surgical care must be given to the patient and the accompanying adult. An emergency contact place, person and telephone number must be included.

6.12 Suitable analgesia should be provided for at least the first day after discharge. Advice on any other regular medication is also necessary.

6.13 A telephone enquiry as to the patient's wellbeing on the following day should be made whenever possible.

This policy document has been prepared having regard to general circumstances, and it is the responsibility of the practitioner to have express regard to the particular circumstances of each case, and the application of this policy document in each case.

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Appendix No. 5: Monitoring during anaesthesia. Review P18 (1995)

AUSTRALIAN AND NEW ZEALAND COLLEGE OF ANAESTHETISTS

A.C.N. 055 042 852

INTRODUCTION

Monitoring of certain fundamental physiological variables during anaesthesia is essential. Clinical judgement will determine how long this monitoring should be continued following completion of anaesthesia.

The Health Care Facility in which the procedure is being performed is responsible for provision of equipment for anaesthesia and monitoring on the advice of one or more designated specialist anaesthetists, and for effective maintenance of this equipment (see College Policy Document 'Recommended Minimum Facilities f or Saf e Anaesthetic Practice in Operating Suites' (T1)).

Some or all of the recommendations in this document may need to be exceeded depending on the physical status of the patient, the type and complexity of the surgery to be performed as well as the requirements of anaesthesia.

The described monitoring must always be used in conjunction with careful clinical observation by the anaesthetist as there are circumstances in which equipment may not detect unfavourable clinical developments.

The following recommendations refer to patients undergoing general anaesthesia or major regional anaesthesia for diagnostic or therapeutic procedures and should be interpreted in conjunction with other Policy Documents published by the Australian and New Zealand College of Anaesthetists.

1. PERSONNEL

Clinical monitoring by a vigilant anaesthetist is the basis of safe patient care during anaesthesia. This should be supplemented by appropriate devices to assist the anaesthetist.

A medical practitioner whose sole responsibility is the provision of anaesthetic care for that patient must be constantly present from induction of anaesthesia until safe transfer to Recovery Room staff or Intensive Care Unit has been accomplished. This medical practitioner must be appropriately trained in Anaesthesia, or be a Trainee Anaesthetist supervised in accordance with College Policy Document 'The Supervision of Trainees in Anaesthesia' (E3).

In exceptional circumstances brief absences of the person primarily responsible for the anaesthetic may be unavoidable. In such circumstances that person may temporarily delegate observation of the patient to an appropriately qualified person who is judged to be competent for the task. Permanent handover of responsibility must be to an anaesthetist who is able to accept continued responsibility for the care of the patient (see College Policy Document *'Handover of Responsibility during an Anaesthetic'* (P10)).

The individual anaesthetist is responsible for monitoring the patient and should ensure that appropriate monitoring equipment is available. Some procedures necessitate special monitoring (e.g. MRI scanning) or remote monitoring to reduce hazard to staff (e.g. radiological procedures) (see College Policy Document 'Recommended Minimum Facilities for Safe Anaesthetic Practice in Organ Imaging Facilities' (T3)).

2. PATIENT MONITORING

2.1 Circulation

The circulation must be monitored at frequent and clinically appropriate intervals by detection of the arterial pulse and measurement of arterial blood pressure by indirect or direct means.

2.2 Ventilation

Ventilation must be monitored continuously by both direct and indirect means.

2.3 Oxygenation

Oximetric values must be interpreted in conjunction with clinical observation of the patient. Adequate lighting must be available to aid with assessment of patient colour.

3. EQUIPMENT

3.1 Oxygen Supply Failure Alarm

An automatically activated device to monitor oxygen supply pressure and to warn of low pressure must be fitted to the anaesthetic machine. This device should shut off the nitrous oxide supply and be capable of maintaining oxygen flow for a limited period (see College Policy Document 'Recommended Minimum Facilities for Safe Anaesthetic Practice in Operating Suites' (T1)).

3.2 Oxygen Analyser

A device incorporating an audible signal to warn of low oxygen concentrations, correctly fitted in the breathing system, must be in continuous operation for every patient when an anaesthetic machine is in use.

3.3 Pulse Oximeter

Pulse oximetry provides evidence of the level of oxygen saturation of the haemoglobin of arterial blood and identifies arterial pulsation at the site of application. A pulse oximeter must be in use for every anaesthetised patient.

3.4 Breathing System Disconnection or Ventilator Failure Alarm

When an automatic ventilator is in use, a device capable of warning promptly of a breathing system disconnection or ventilator failure must be in continuous operation. This device must be automatically activated.

3.5 Electrocardiograph

Equipment to monitor and continually display the electrocardiograph must be

available for every anaesthetised patient.

3.6 Temperature Monitor

Equipment to monitor temperature continuously must be available for every anaesthetised patient.

3.7 Carbon Dioxide Monitor

A monitor of carbon dioxide level in inhaled and exhaled gases must be exclusively available for every patient.

3.8 Neuromuscular Function Monitor

Equipment to monitor neuromuscular function must be available for every patient in whom neuromuscular blockade has been induced.

3.9 Volatile AnaestheticAgent Monitor

Equipment to monitor the concentration of inhaled anaesthetics must be exclusively available for every patient undergoing general anaesthesia. This recommendation should be implemented as soon as possible but in any case no later than 1 January 1998.

3.10 Other Equipment

When clinically indicated, equipment to monitor other physiological variables such as cardiac output should be available.

RELATED DOCUMENTS

T1 Recommended Minimum Facilities for Safe Anaesthetic Practice in Operating Suites

T3 Recommended Minimum Facilities for Safe Anaesthetic Practice in Organ Imaging Facilities

E3 The Supervision of Trainees in Anaesthesia

P10 Handover of Responsibility During an Anaesthetic

This policy document has been prepared having regard to general circumstances, and it is the responsibility of the practitioner to have express regard to the particular circumstances of each case, and the application of this policy document in each case.

Policy documents are reviewed from time to time, and it is the responsibility of the practitioner to ensure that the practitioner has obtained the current version. Policy documents have been prepared having regard to the information available at the time of their preparation, and the practitioner should therefore have regard to any information, research or material which may have been published or become available subsequently.

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Appendix No. 6: Recommended minimum facilities for safe anaesthetic practice in dental surgeries. Review T5 (1995)

AUSTRALIAN AND NEW ZEALAND COLLEGE OF ANAESTHETISTS

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The safe provision of anaesthesia in Dental Surgeries requires appropriate staff, facilities and equipment for proper patient safety. These are specified in this Document.

1. PRINCIPLES OF ANAESTHETIC CARE

1.1 Anaesthesia in Dental Surgeries should be administered only by medical practitioners with appropriate training in anaesthesia or by trainees supervised according to College Policy Documents 'The Supervision of Trainees in Anaesthesia' (E3) and 'Privileges in Anaesthesia' (P2).

1.2 Every patient presenting for anaesthesia in Dental Surgeries should have a pre-anaesthetic consultation by a medical practitioner who has appropriate training in anaesthesia. College Policy Document 'Preanaesthetic Consultation' (P7).

1.3 Appropriate monitoring of physiological variables must occur during anaesthesia. College Policy Document 'Monitoring During Anaesthesia' (P18).

1.4 On occasion the anaesthetist may decide that the condition of the patient (having regard to the facilities available and/or the patient's health status) does not permit of safe care in the dental surgery.

2. STAFFING

2.1 In addition to the nursing staff required by the person carrying out the procedure, there must be:

2.1.1 An assistant to the anaesthetist. See College Policy Document 'Minimum Assistance for the Safe Conduct of Anaesthesia' (P8).

2.1.2 Adequate assistance in positioning the patient.

2.1.3 Adequate technical assistance to ensure proper servicing of all equipment used.

3. DENTAL SURGERIES

3.1 Anaesthetic Equipment

3.1.1 Essential requirements are listed below. Where a range of equipment is available, the dental surgery is expected to provide the type most suitable to its needs.

3.1.2 Anaesthetic equipment, agents and drugs in dental surgeries may be provided by the dentist or brought by the anaesthetist to the dental surgery. In the former case, it is essential that the dentist seek advice from an anaesthetist who is experienced in anaesthesia in the dental environment.

3.1.3 There must be an anaesthetic machine for each anaesthetising location which is capable of delivering oxygen and nitrous oxide as well as other anaesthetic agents which are in common use. Essential equipment includes:

3.1.3.1 Suitable calibrated vaporisers for the delivery of inhalational anaesthetic agents.

3.1.3.2 A range of suitable breathing systems.

3.1.3.3 Breathing systems suitable for paediatric use if children are to be anaesthetised.

3.1.4 Safety devices which must be present on every machine include:

3.1.4.1 An indexed gas connection system.

3.1.4.2 A reserve supply of oxygen.

3.1.4.3 An oxygen supply failure warning device. See College Policy

Document 'Monitoring During Anaesthesia' (P18).

3.1.4.4 A breathing system high pressure relief valve.

3.1.4.5 An oxygen concentration analyser with appropriate alarm limits. See College Policy Document 'Monitoring During Anaesthesia' (P18).

3.1.4.6 Every anaesthetic machine purchased after 1 January 1996 shall have a device to prevent the supply of a hypoxic gas mixture whenever nitrous oxide is administered.

3.1.4.7 Every anaesthetic machine purchased after 1 January 1996 shall have an approved non-slip connection for the common gas outlet whenever a circle system is in use.

3.1.5 A separate means of inflating the lungs with oxygen must be provided in each anaesthetising location. This apparatus should comply with the current requirements of the relevant national Standards. Its oxygen supply should be independent of the anaesthetic machine.

3.1.6 Suction apparatus must be available for the exclusive use of the anaesthetist at all times together with appropriate hand pieces and endotracheal suction catheters. This apparatus should comply with the current requirements of the relevant national Standards. Provision must be made for an alternative suction system in the event of primary suction failure.

3.1.7 In every anaesthetising location there should be:

3.1.7.1 Appropriate protection for the anaesthesia team against biological contaminants which shall include disposable gloves and eye shields.

3.1.7.2 A stethoscope

3.1.7.3 A sphygmomanometer

3.1.7.4 Monitoring equipment complying with College Policy Document 'Monitoring During Anaesthesia' (P18).

3.1.7.5 An appropriate range of face masks.

3.1.7.6 An appropriate range of airways.

3.1.7.7 Two laryogoscopes with a range of suitable blades.

3.1.7.8 An appropriate range of endotracheal tubes and connectors.

3.1.7.9 A range of endotracheal tube introducers.

3.1.7.10 Inflating syringe and clamps.

3.1.7.11 Magill's forceps.

3.1.7.12 A suitable range of adhesive and other tapes.

3.1.7.13 Scissors.

3.1.7.14 Sterile endotracheal lubricant.

3.1.7.15 Vascular tourniquets.

3.1.7.16 Intravenous infusion equipment with an appropriate range of cannulae and solutions.

3.1.7.17 Means for the safe disposal of items contaminated with biological fluids as well as of "sharps" and waste glass.

3.1.7.18 Equipment suitable for the establishment of regional anaesthetic nerve blocks.

3.1.7.19 Throat packs.

3.1.7.20 Provision for scavenging of anaesthetic gases and vapours with interface equipment which precludes over-pressurisation of the anaesthesia breathing circuit.

3.1.7.21 A cardiac defibrillator.

3.1.8 Other requirements for safe anaesthesia include:

3.1.8.1 Appropriate lighting for the clinical observation of patients which comply with the current requirements of the relevant national Standards.

3.1.8.2 Emergency lighting.

3.1.8.3 Telephone/Intercom to communicate with persons outside the anaesthetising location.

3.1.8.4 Refrigeration facilities for the storage of drugs and biological products.

3.1.8.5 The means to maintain room temperature in the anaesthetising location within the range of 18-28 °C.

3.1.8.6 A dental operating chair which will allow the patient to be rapidly placed in the horizontal or head-down position.

3.2 Drugs

3.2.1 In addition to the drugs and agents commonly used in anaesthesia, drugs necessary for initial management of conditions which may complicate or co-exist with anaesthesia must also be available:

Anaphylaxis

Cardiac arrhythmias

Cardiac arrest

Pulmonary oedema

Hypotension

Hypertension

Bronchospasm

Respiratory depression

Hypoglycaemia

Hyperglycaemia

Adrenal dysfunction

Malignant hyperpyrexia

Blood coagulopathy

3.2.2 In ensuring the availability of drugs for the treatment of these conditions, the processes outlined in 3.1.2 should be followed.

3.2.3 Appropriate mechanisms must exist for the regular replacement of these drugs after use and/or their expiry date has been reached.

3.2.4 Dantrolene (used in the management of malignant hyperpyrexia) should be rapidly available from a nearby hospital which holds adequate supplies of this drug.

3.3 Routines for Checking, Cleaning and Servicing Equipment

3.3.1 Regular sterilising, cleaning and housekeeping routines for the care of equipment should be established.

3.3.2 Documented servicing of the anaesthetic machine and medical gas equipment by an appropriate organization must be carried out at least twice a year. After any modification to the gas distribution system, gas analysis and flow measurement must be carried out and documented before use.

3.3.3 A copy of the College Policy Document 'Protocol for Checking an Anaesthetic Machine Before Use' (T2) or a similar document should be available on each anaesthetic machine.

3.4 Recovery Area

3.4.1 Recovery from anaesthesia should take place under appropriate supervision in a designated area which conforms with College Policy Document 'Guidelines for the Care of Patients Recovering from Anaesthesia' (P4).

3.4.2 Contingency plans should exist which would allow rapid patient transfer in an emergency from the dental surgery to hospital care under adequate medical supervision.

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Appendix No. 7: Microsoft Access database form