International Journal of Paediatric Dentistry 2004; **14:** 9–16

Morbidity following dental treatment of children under intubation general anaesthesia in a day-stay unit

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Summary. *Objectives.* To determine which variables were best related to the overall morbidity of a child undergoing dental general anaesthetic (GA) and then to use these variables to determine those factors that might influence the extent and severity of morbidity experienced by healthy children following dental GA.

Sample and methods. Data were collected on anxiety, pain and morbidity, GA procedure and dental procedure from 121 children attending a day stay GA unit for dental treatment. Patients were interviewed preoperatively, postoperatively before discharge then four further times over the next 148 h. Data were analysed using multivariate regression.

Results. Thirty-one per cent of subjects had restorative work, 60% had at least one tooth extracted, 54% had a surgical procedure. Use of local analgesia reduced postoperative pain whilst an increase in the number of surgical procedures increased it. Increase in anaesthetic time was related to increased odds of feeling sleepy and nauseous, females were more likely to complain of sleepiness or weakness. Feelings of dizziness were increased if the patient was given local analgesia during the procedure.

Conclusions. Pain following dental GA was the most prevalent and long lasting symptom of postoperative morbidity in this study. Reductions in operating time and improvement in pain control have the potential to reduce reported morbidity following dental GA.

Introduction

Recent years have seen a change in the professional and public perception of general anaesthesia (GA) for dentistry in children. A greater appreciation of the risks involved has resulted in more dental treatment being carried out on the conscious patient. Unfortunately it is impossible to completely eliminate the use of GA for dental treatment in children, there will always be patients and procedures where it is unavoidable.

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Given that GA for dental treatment will continue to be carried out for the foreseeable future, it is important to ensure that it is carried out as safely and as comfortably as possible. When considering the risks associated with a GA, mortality is usually the first problem to jump to mind. However, death following dental GA in healthy children is relatively unlikely [1], morbidity is a much more common problem.

There is little data published on morbidity following dental GA. Holt *et al*. [2] looked at 103 children having dental GA and recorded that 94 of the participants had symptoms of morbidity at some stage after the procedure. Enever *et al*. [3] looked at morbidity retrospectively and reported that it was negligible. However that study was reliant on patients recall of the events following the surgery, which

may have occurred some months previously, and perception may have changed over time. Finally Prabhu *et al*. [4] looked at postoperative outcomes in a mixed group of disabled and anxious patients. Again they reported that postoperative morbidity was negligible.

Unfortunately morbidity in all these papers was measured by recording very different signs and symptoms – this large number of possible variables is common to other studies looking at morbidity post-GA [5] and makes data analysis very difficult. Morbidity following dental GA requires investigation, however, this is difficult unless appropriate outcome variables can be defined. Therefore it was the aim of this study to determine which variables are best related to the overall morbidity of a child undergoing dental GA, and then to use these variables to determine the extent and severity of morbidity experienced by healthy children following dental GA.

Materials and methods

Data were collected from 121 children attending a day stay GA unit for dental treatment at the Eastman Dental Hospital, London over an 11-month period. Patients were included in the study if they were aged between 6 and 16, could communicate well in English, had a telephone at home and gave informed consent. Only patients who were classified as ASA I or II were selected.

Data collected

Data were collected on anxiety, pain and morbidity, GA procedure and dental procedure for each patient by the investigator (SA).

Anxiety, pain and morbidity. These data were recorded at the following intervals (with the exception of the preoperative examination).

- Immediately preoperatively (anxiety and pain only)
- Postoperatively just before discharge
- On the night of the procedure (within 12 h)
- On the second night following the procedure (within 36 h)
- On the third night (within 72 h)
- One week after the procedure (within 148 h).

Data were collected by structured interview either face to face (pre- and immediately post-operation) or using a telephone (post-operation after discharge).

Anxiety was assessed using the Frankl [6] and Venham [7] scales, pain was assessed using the Visual [8] and Verbal [9] analogue scales. Further assessment of morbidity was made by asking the patients if they suffered any symptoms from a list of 20 which included headache, pain at operation site, nausea, bad dreams, number of painkillers taken and backache.

GA procedure

This data was collected by the investigator who was present during the whole procedure. The following data were collected:

- Length of time of intubation
- Time of extubation
- Medication given by the anaesthetist.

In addition, time of recovery and level of recovery were also assessed. Time of recovery was recorded as time between extubation and the patient opening their eyes. Level of recovery was recorded by using the Aldrete [10] scale. Level of discomfort was also measured using the Hanallah [11] scale. Both these measures were recorded whilst the patient was still in the recovery room. Patients were taken to the main ward once it was felt that they were conscious and in a stable condition.

Dental procedure. DMFS (dmfs) and DMFT (dmft) for primary and permanent teeth were recorded for each patient before treatment began. The type and number of extractions and surgical procedures was recorded as well as whether or not restorative treatment was carried out. Data was subsequently grouped for the purposes of statistical analysis as:

- Restorative treatment
- Primary tooth extractions
- Permanent tooth extractions
- Surgical procedure (any procedure where a mucoperiosteal flap was raised).

Other variables recorded included the dental operator, number of sutures placed, whether or not steroids were given and whether or not local analgesia (LA, 2% lignocaine, 1 : 80 000 adrenaline) was used.

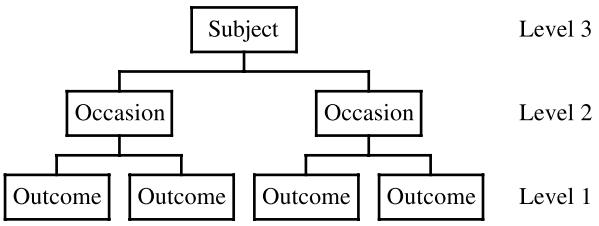

Fig. 1. The 3-level data structure explored in this study.

Statistical analysis

Morbidity data were recorded at five distinct time intervals, as already described. The data collected therefore had a complex structure comprising multiple outcomes that were recorded on repeated occasions, which form a natural hierarchy as illustrated in Fig. 1. The data were analysed by multilevel multivariate regression analysis using all the variables collected before and during the dental GA as possible explanatory variables for the outcome variables selected.

Multilevel methods were used to accommodate the generic hierarchy of five separate postoperative interview occasions nested within subjects [12]. Multivariate regression was used as it allowed multiple outcomes to be combined and analysed in one model. This increases statistical power through use of all the available data [13]. In addition, within the multilevel multivariate framework, outcome intercorrelations which describe the interactions between outcome variables can be evaluated. The overall correlation is effectively separated into that between subjects (irrespective of any correlation over time) and that between times (within subjects).

The data were examined to determine which of the outcome variables was 'measurable', i.e. which variables peaked after the procedure had been carried out and then decreased in reported frequency as time passes. On the basis of the raw data, the outcome variables were separated into two discrete groups for analysis.

1 Morbidity related to the procedure. This was recorded by the number of hours that postoperative pain persisted, expressed either by reported pain at the operation site or the Verbal analogue scale.

2 Morbidity related to the general anaesthetic. This was recorded by the reported variables 'sleepy', 'weak', 'dizzy' or 'nauseous'.

Results

One hundred and twenty-one children took part in this study. Their mean age was 10·8 (SD = 3·2, range = 6–16), 48% of them were boys.

Anaesthetic procedures

The majority of patients were induced by the intravenous agent propofol (83%), with the remainder induced by sevoflurane or a mixture of propofol and sevoflurane. Patients were then maintained using isoflurane. An analgesic was administered rectally for all patients, this was a combination of alfentanil and diclofenac in most cases (79%), other combinations used included alfentanil and codeine phosphate or alfentanil and paracetemol. Only six children (5%) were given antiemetics (cyclizine, given prior to feeling nauseous).

The mean anaesthetic time was 54 min (SD = 23) and the mean recovery time was 13 min (SD = 7). The Hanallah scale indicated that over 50% of the children woke up without any signs of discomfort, and the Aldrete scale was also satisfactory with all patients having a score of 7 out of 8 or more indicating they were suitable for transfer to the ward.

Dental procedures

As dental data are highly skewed, the median and inter quartile range (IQR) were used to describe dmf/DMF rather than the mean and SD. The median value for DMFT and dmft was 0 (IQR 0·2 and 0·3, respectively). Thirty-one per cent of subjects had restorative work carried out, 60% of subjects had at least one primary tooth extracted, 39% at least one permanent tooth extracted and 54% had some kind of surgical procedure. Ninety-two percent of patients were given local anaesthetic during the procedure (Table 1).

Preoperative pain and anxiety

Just over half of the children scored 0 for the Venham scale indicating that they were not anxious (51%) and 0 for the Verbal rating scale indicating they had no pain (83%) (Tables 2 and 3). Data from the Frankl and Visual analogue scales are not presented as these were found to be unreliable in younger children.

Postoperative morbidity

Sleepiness was most commonly reported 1 h after the GA (84%) closely followed by pain at the

Table 1. Dental procedures.

Procedure	Proportion of patients having this procedure (%)	Mean number carried out per patient (SD)	Number range of procedures carried out
Restorations	31	0·3 (0·5)	0–1
Primary tooth extractions	60	2·6 (3·3)	0–14
Permanent tooth extractions	39	1·2 (1·6)	0–6
Surgicals	54	0·8 (0·9)	0–5

Table 2. Venham scale (preoperative anxiety).

Score	0	1	2	3	4	5	6	7	8
Frequency	62	23	8	8	8	8	2	0	2
Percentage	51	19	7	7	7	7	2	0	2

operation site (74%) and weakness (68%). Only 21% of patients complained of nausea. After 72 h, variables expressing morbidity related to the GA were recorded in less than 10% of the population studied, although 50% of those interviewed still had pain at the operation site.

Morbidity related to the procedure. Local analgesia and the number of surgical procedures were significantly associated ($P < 0·05$) with postoperative pain (Table 4). The odds of experiencing pain at the operation site was reduced amongst patients who had received local analgesia (Odds Ratio (OR) = 0·39, 95% CI 0·15, 1·00). The odds were elevated, however, with increasing number of surgical procedures (OR = 1·95, 95% CI 1·41, 2·71). The odds of pain (as recorded by the Verbal Rating scale) was also reduced if local analgesia was given during the procedure (OR = 0·59, 95% CI 0·80, 0·83) and elevated with increasing numbers of surgical procedures (OR = 1·37, 95% CI 1·19, 1·58).

Morbidity related to the general anaesthetic. Anaesthetic time, gender and local analgesia were significantly related ($P < 0·05$) to postoperative sleepiness, nausea, weakness, and dizziness (Table 5). Sleepiness and nausea were both related to anaesthetic time. For every 10-minute increase in anaesthetic time the patient had 15% (95% CI 14%, 16%) increased odds of feeling sleepy and 19% (95% CI 17%, 21%) increased odds of feeling nauseous. Gender was also an important factor in feeling

Table 3. Verbal rating scale (preoperative pain).

Score	1 (none)	2 (mild)	3 (Moderate)	4 (strong)	5 (severe)
Frequency	101	14	0	4	2
Percentage	83	12	0	3	2

Table 4. Reported postoperative pain.

	Odds Ratio (95% CI)	
Factors	Pain at operation site	Pain as described by verbal rating scale
Local analgesia given	0·39 (0·15, 1)	0·59 (0·38, 0·91)
Number of surgicals	1·95 (1·41, 2·71)	1·37 (1·19, 1·58)
Length of time until recovery	–	0·82 (0·80, 0·83)

Table 5. Reported postoperative feelings of dizziness, weakness, sleepiness or nausea.

	Odds Ratio (95% CI)			
	Dizziness	Weakness	Sleepiness	Nausea
Length of anaesthesia (per 10 min)	–	–	1·15 (1·14, 1·16)	1·19 (1·17, 1·21)
Female	–	1·99 (1·21, 3·29)	1·87 (1·13, 3·12)	–
Local analgesia during procedure	3·14 (1·31, 7·54)	–	–	–

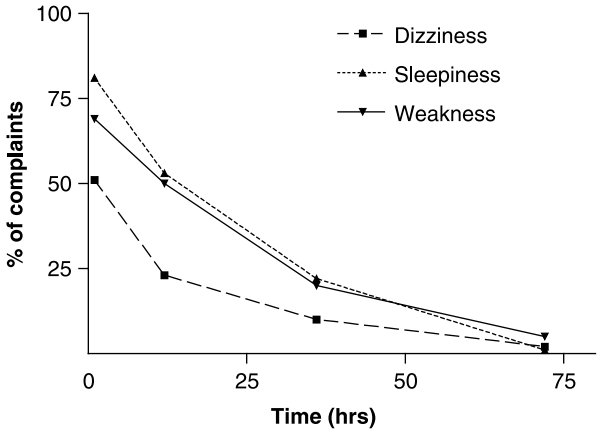

Fig. 2. Relationship between selected morbidity outcome variables and time post GA.

sleepy, with females having an OR of 1·87 (95% CI 1·13, 3·12). Weakness was related to gender also (for females: OR = 1·99, 95% CI 1·21, 3·29). Feelings of dizziness were increased if the patient was given local analgesia during the procedure (OR = 3·14, 1·31, 7·54).

The mean outcome of each morbidity measure, averaged across all subjects and plotted over time, is shown in Fig. 2. Pain was sustained the longest of all five morbidity measures, with nausea being the least common outcome experienced amongst subjects.

The multivariate framework facilitated the evaluation of outcome intercorrelations summarized in Table 6. Generally, correlations were weaker within subjects than between subjects. For instance, individual subjects experienced similarity in changes in pain, dizziness and weakness across time. In fact, weakness was correlated with all outcomes across time and sleepiness was correlated only with dizziness. In contrast, pain and dizziness were not significantly correlated between subjects, although pain was highly correlated with all other outcomes across subjects. The two highest correlations indicate that individuals experiencing sleepiness were also likely to experience weakness ($r = 0{\cdot}76$), and those suffering dizziness were also likely to have nausea ($r = 0{\cdot}79$); even although patterns over time of these latter two outcomes were not significantly related.

Discussion

This study attempted to determine which variables were best related to the overall morbidity of a child undergoing dental general anaesthetic (GA) and then to use these variables to determine those factors that might influence the extent and severity of morbidity experienced by healthy children following dental GA.

Using multilevel multivariate modelling for multiple outcome data yields more efficient and effective analyses, optimizing estimates of statistical significance, reducing the possibility of *Type I* and *Type II* statistical errors. Furthermore, multilevel techniques are especially valuable in analysing longitudinal data. This study involved data that exhibited both complexities, requiring the application of multilevel multivariate techniques in favour of any single-level alternatives. These methods optimized the analytical process, getting the most out of the research data by reducing standard errors and associated confidence intervals. The multivariate approach also facilitated the evaluation of outcome intercorrelations, providing even greater insight into how the selected outcome variables related to each other over time within and between subjects. Researchers should not be deterred by the complexity of these methods, especially within dentistry where much of the data collected is inherently hierarchical in nature.

The results suggest that morbidity related to the GA was less of a problem than morbidity related to the dentistry (Fig. 2). The numbers of subjects complaining of nausea, sleepiness, weakness, and dizziness tailed off very quickly after the first postoperative examination. These variables did not

Table 6. Correlations between the selected outcome measures: (i) across subjects, and (ii) across time intervals.

		(i) correlation across subjects				
		Pain	Nausea	Dizziness	Sleepiness	Weakness
(ii) correlation across time intervals	Pain	–	0·47	ns	0·64	0·49
	Nausea	ns	–	0·79	ns	ns
	Dizziness	0·15	ns	–	ns	ns
	Sleepiness	ns	ns	0·25	–	0·76
	Weakness	0·11	0·35	0·29	0·28	–

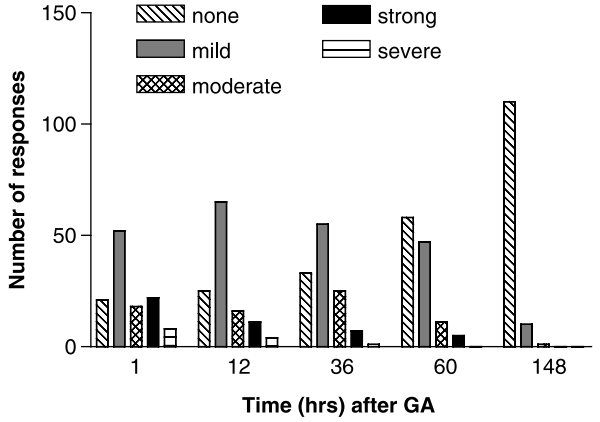

Fig. 3. Verbal rating scale of pain at each postoperative interview.

appear to be associated with postoperative morbidity after 36 h. At this point, 70% of patients were still complaining of postoperative pain, compared to only 22% who were complaining of sleepiness. Obviously, not all of the patients complaining of pain had severe pain. However, analysis of the responses (Fig. 3) demonstrates that, at 36 h, almost a third (28%) of all subjects felt that they were experiencing moderate pain and 9% of those questioned thought they had strong or severe pain. A similar pattern was reported in previous research [2].

Children over the age of 5 years were chosen for this study as it was felt that they were able to accurately report their signs and symptoms. Different results might have been obtained if children under the age of six had been chosen. However, a study of this nature would probably require a different set of outcome variables that do not rely as heavily on individual self-reporting. This could be the subject of further investigation.

This study indicated that dental treatment had a significant effect on postoperative morbidity – not only did it have an effect on those variables that were hypothesized to be influenced by dental treatment, it also influenced those variables that were hypothesized to be related to the general anaesthetic. It would seem that simple measures, such as reducing the operating time or providing proper pain control, have the potential to decrease postoperative discomfort. It is interesting to note that anaesthetic procedures seem to have had no effect on postoperative morbidity. However, this is probably because there was very little variation in the procedures carried out during this study.

Findings less easy to explain are the positive relationship between being female and complaining of sleepiness or weakness, and the positive relationship between having local analgesia and dizziness. The relationship between gender and morbidity has been reported previously [14,15] and it is hypothesized that this may be caused by physiological differences between men and women. Another possible reason is that women are known to report symptoms more often than men, however, this seems unlikely in this study as specific questions requiring a response were directed at participants. It may be appropriate to provide additional warning to female patients. The relationship between local analgesia and dizziness will require further investigation.

Conclusions

In conclusion, pain following dental GA was the most prevalent and long lasting symptom of postoperative morbidity in this study. Improvement in pain control has the potential to much reduce reported morbidity following dental GA.

Résumé. *Objectifs*. Déterminer quelles variables sont les plus reliées à la morbidité infantile générale après anesthésie générale (GA) puis utiliser ces variables afin de déterminer les facteurs qui peuvent influencer l'importance et la sévérité de la morbidité des enfants sains après GA dentaire.
Echantillon et méthodes. Les données recueillies concernaient l'anxiété, la douleur et morbidité, la procédure de GA et les actes dentaires chez 121 enfants bénéficiant de soins dentaires sous GA. Les patients ont été interrogés avant l'intervention, avant sortie puis 4 fois durant les 148 heures suivantes. Les données ont été analysées par régression multivariée.
Résultats. Trente et un pour cent des sujets ont bénéficié d'un traitement restaurateur, 60% ont eu au moins une dent extraite, 54% un acte chirurgical. L'utilisation d'une anesthésie locale a diminué la douleur post-opératoire, celle-ci augmentant avec le nombre d'actes chirurgicaux. La durée de l'anesthésie était reliée à plus de somnolence et de nausées, les filles étant plus sujettes à se plaindre de somnolence et faiblesse. Les sensations de vertige étaient augmentées si une anesthésie locale était administrée pendant l'intervention.
Conclusions. La douleur était le symptôme post-opératoire le plus fréquent et le plus durable dans

cette étude. La réduction du temps opératoire et l'amélioration du contrôle de la douleur ont tous les deux le potentiel pour réduire la morbidité après soins dentaires sous GA.

Zusammenfassung. *Ziele*. Bestimmung derjenigen Variablen, welche am besten mit der Gesamtmorbidität von Kindern korreliert, welche einer Vollnarkose unterzogen wurden. Diese Variablen sollten dann dazu genutzt werden, die postoperative Morbidität gesunder Kinder nach einer Behandlung in Narkose zu bestimmen.
Stichprobe und Methode. Es wurden Daten gesammelt von 121 Kindern, die in einer Einrichtung zur ambulanten Zahnbehandlung in Narkose behandelt worden waren. Folgende Parameter wurden erhoben: Angst, Schmerz, Morbidität, Art der Narkose, Art der Zahnbehandlung. Die Patienten wurden prä- und postoperativ (vor Entlassung nach Hause) interviewt, weiterhin bei vier weiteren Folgeterminen. Die Daten wurden mittels multivariater Regressionsanalyse analysiert.
Ergebnisse. 31% der Patienten waren restaurativ behandelt worden, 60% hatten mindestens einen Zahn extrahiert bekommen, bei 54% wurden weitere chirurgische Maßnahmen durchgeführt. Die Verwendung von Lokalanästhetika reduzierte die postoperative Schmerzen, während die Zunahme der Zahl chirurgischer Maßnahmen die Schmerzen vergrößerte. Eine Zunahme der Narkosedauer war korreliert mit der Wahrscheinlichkeit, danach schläfrig zu sein oder Übelkeit zu empfinden. Mädchen zeigten häufiger Schläfrigkeit oder Schwächegefühl. Schwindel trat häufiger bei Patienten auf, welche während der Narkose zusätzlich Lokalanästhetikum erhalten hatten.
Schlussfolgerungen. Schmerz nach Zahnbehandlung in Narkose war die häufigste und am längsten andauernde Morbidität in dieser Studie. Die Reduktion der Behandlungsdauer und eine Verbesserung der Schmerzausschaltung besitzen ein Potential, die postoperative Morbidität zu reduzieren.

Resumen. *Objetivos*. Determinar qué variables estaban más relacionadas con la morbilidad general de un niño tratado bajo anestesia general (AG) y posteriormente utilizar estas variables para determinar los factores que pudiesen influir en la extensión y severidad de la morbilidad experimentada por niños sanos tras AG dental.
Muestra y métodos. Se recogió la información de 121 niños que asistieron a una unidad de AG de un día para tratamiento dental. Esta información incluyó ansiedad, dolor y morbilidad, procedimiento de la AG y procedimiento dental. Los pacientes fueron entrevistados en el pre-operatorio, post-operatorio y otras cuatro veces más durante las 148 horas después de la intervención. La información fue analizada usando la regresión múltivariante.
Resultados. Al 31% de los sujetos se les realizó trabajos restauradores, al 60% se le extrajo al menos un diente y al 54% se le realizó algún procedimiento quirúrgico. El uso de anestesia local redujo el dolor post-operatorio, mientras un aumento en el número de procedimientos quirúrgicos aumentaba el dolor. El aumento en el tiempo de anestesia se relacionó con mayor probabilidad de sentirse adormecido y con náuseas. Las mujeres eran más propensas a quejarse de somnolencia o debilidad. Las sensaciones de mareo aumentaron si el paciente había recibido analgesia local durante el procedimiento.
Conclusiones. El dolor después de AG dental fue el síntoma más prevalente y duradero de la morbilidad post-operatoria en el presente estudio. Tanto la reducción en el tiempo operatorio como la mejoría en el control del dolor, tienen el potencial de reducir la morbilidad señalada tras la AG dental.

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