OXYGEN DESATURATION AFTER DENTAL ANAESTHESIA

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SUMMARY
The incidence of oxygen desaturation (<91%) was measured by pulse oximetry during recovery from outpatient dental anaesthesia in 120 ASA grade I and II children. Alternate cases were given supplementary oxygen 5 litre min⁻¹ by mask. Eighteen of 60 children (30%) given air and 14 of 60 (23%) given oxygen exhibited desaturation (P > 0.05). Desaturation was more likely to occur if the child was cared for during recovery by locum rather than permanent nursing staff: 22 of 64 (34%) compared with 10 of 56 (18%) (P < 0.05). It is concluded that significant desaturation is common after brief dental anaesthesia, that the incidence of desaturation is not reduced significantly by supplementary oxygen and that careful supervision of patients by experienced recovery room staff is necessary after dental anaesthesia.

KEY WORDS

Current practice at this hospital involves selective administration of supplementary oxygen to patients after outpatient dental anaesthesia, as requested by the anaesthetist or recovery room nursing staff. This is in contrast with routine use of oxygen in the recovery room after inpatient dental surgery. This difference in procedure exists because postoperative desaturation was thought to be uncommon after outpatient dental anaesthesia because duration of anaesthesia and recovery is short and patients are generally young, without significant medical problems. The principal cause of desaturation—airway obstruction—is not prevented by supplementary oxygen, although its severity might be ameliorated. The procedure is safe—the estimated mortality rate for dental general anaesthetics given to hospital outpatients, where anaesthesia is the principal cause of death, is 1:593000 [1] and thus oxygen is not deemed necessary. Furthermore, if supplementary oxygen were given to all children, a piped oxygen supply may be necessary and this is currently not available in the Dental Institute. The hypothesis tested in this study was that supplementary oxygen had no effect on the incidence of postoperative desaturation in children undergoing outpatient dental anaesthesia.

PATIENTS AND METHODS
One hundred and twenty unpremedicated ASA grade I and II children aged 2-14 yr presenting for outpatient dental extractions were studied after completion of anaesthesia and transfer in the lateral position to the immediately adjoining recovery area. Subjects were allocated alternately to receive either air (group 1) or supplementary oxygen 5 litre min⁻¹ via an MC mask (group 2) after baseline oxygen saturation ("starting SpO₂") had been recorded from a finger probe by an Ohmeda Biox 3700e pulse oximeter. The plethysmographic waveform from the pulse oximeter was displayed continuously and low quality or artefactual SpO₂ readings were rejected. SpO₂ was measured continuously until the child was awake and sitting upright ("final SpO₂"). The smallest value of SpO₂ observed during recovery was recorded ("smallest SpO₂"). Details of age, sex, race, number of teeth extracted, duration of anaesthesia and monitoring, recovery nurse, presence of upper airway obstruction, difficulty supplying oxygen and time to discharge were noted also. No attempt was made to influence the choice of anaesthetic given. Duration of anaesthesia was defined as the interval from application to removal of the nasal–oral mask. Patients were excluded if the trachea required intubation, or if the anaesthetist or recovery room nursing staff thought that oxygen was clinically indicated.

Clinically significant desaturation was taken as SpO₂ < 91% which, under standard conditions, is likely to correspond to a PO₂ of < 8 kPa [2]. Differences between the two groups were analysed by the Mann-Whitney, Kruskal-Wallis and chi-square tests (with Yates' correction) as appropriate, using a BDMP statistical package, with the level of statistical significance taken as P < 0.05.

RESULTS
Twenty-two of 142 children were excluded as another child was already being studied at the same time (20), supplementary oxygen was requested (one) and one child allocated to receive oxygen did not receive it as the oxygen cylinder on her trolley was empty. There were no significant differences between the two groups in age, sex, race, number of teeth extracted, duration of anaesthesia, monitoring or time to discharge (table I). The starting SpO₂ did not differ significantly between the two groups (fig. 1).
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TABLE I. Comparison of children given air (group 1) and supplementary oxygen (group 2) after anaesthesia. (No. (%) or median (range) of non-parametric data observed)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1 (n = 60)</th>
<th>Group 2 (n = 60)</th>
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</thead>
<tbody>
<tr>
<td>Sex (M/F)</td>
<td>33/27</td>
<td>27/33</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>7 (2-13)</td>
<td>5 (2-13)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>22 (37)</td>
<td>24 (40)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>32 (53)</td>
<td>29 (48)</td>
</tr>
<tr>
<td>Negroid</td>
<td>6 (10)</td>
<td>5 (8)</td>
</tr>
<tr>
<td>Oriental</td>
<td>0 (0)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>No. of teeth removed</td>
<td>3 (1-10)</td>
<td>3 (1-8)</td>
</tr>
<tr>
<td>Anaesthesia (min)</td>
<td>5 (1-15)</td>
<td>5 (2-12)</td>
</tr>
<tr>
<td>Monitored (min)</td>
<td>8 (1-18)</td>
<td>6 (1-19)</td>
</tr>
<tr>
<td>Recovery-discharge time (min)</td>
<td>20 (5-50)</td>
<td>20 (10-55)</td>
</tr>
</tbody>
</table>

TABLE II. Fraction (percentage) of children exhibiting desaturation <91% during recovery from outpatient dental anaesthesia under the supervision of permanent or locum staff

<table>
<thead>
<tr>
<th></th>
<th>Permanent</th>
<th>Locum</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>6/29 (21)</td>
<td>12/31 (39)</td>
<td>18/60 (30)</td>
</tr>
<tr>
<td>Group 2</td>
<td>4/27 (15)</td>
<td>10/33 (30)</td>
<td>14/60 (23)</td>
</tr>
<tr>
<td>Total</td>
<td>10/56 (18)</td>
<td>22/64 (34)</td>
<td>32/120 (27)</td>
</tr>
</tbody>
</table>

The median smallest $\text{SpO}_2$ was significantly less in group 1 than in group 2: 93% vs 95% ($P < 0.001$) (fig. 1). Desaturation was slightly more common in group 1—18 of 60 (30%) compared with 14 of 60 (23.3%) in group 2—but this difference was not statistically significant ($0.5 < P < 0.1$). Almost equal numbers of children were recovered by four permanent and three locum (agency SRN) nursing staff (table II). Although 59% of children recovered by locum staff received supplementary oxygen, 34% of these children suffered significant desaturation compared with 18% recovered by permanent staff ($P < 0.05$) (fig. 2). Difficulty in supplying oxygen was noted in eight of 60 children allocated to receive it. Upper airway obstruction was audible in only 12 of the 120 children: of these, 11 exhibited desaturation and 10 were recovered by locum staff. Marked agitation was not a good predictor of desaturation, occurring in only six of 11 children with agitation, and was not observed in 26 of 32 children with overall desaturation.

Anaesthesia was induced with propofol in five children (three in group 1) and enflurane in two children (one in each group), but otherwise anaesthesia was induced and maintained with halothane in oxygen and nitrous oxide. A nasal-oral airway was inserted by the anaesthetist in seven children allocated to oxygen: three of these had desaturation compared with 18% recovered by permanent staff ($P < 0.05$) (fig. 2). Difficulty in supplying oxygen was noted in eight of 60 children allocated to receive it. Upper airway obstruction was audible in only 12 of the 120 children: of these, 11 exhibited desaturation and 10 were recovered by locum staff. Marked agitation was not a good predictor of desaturation, occurring in only six of 11 children with agitation, and was not observed in 26 of 32 children with overall desaturation.

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The principal factor associated with postoperative desaturation in this study was supervision of recovery by permanent or by locum nursing staff (table II). Desaturation has been noted to be common during dental anaesthesia performed by supervised undergraduates [3]. Postoperative audible upper airway obstruction was observed more commonly with locum staff: it occurred in 11 of 23 children with desaturation, compared with only one of 88

**DISCUSSION**

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![Fig. 1. Frequency distributions of starting, smallest and final values of oxygen saturation during recovery from outpatient dental anaesthesia in children.](image)
Not affect the incidence of desaturation. In contrast, increasing the inspired oxygen concentration receiving supplementary oxygen (group 2), this did not affect the incidence of desaturation.

The duration of desaturation was not timed as the duration of desaturation is so common, it may contribute to the principal cause of desaturation during anaesthesia also, and not increased shunt or decreased cardiac output.

Significant oxygen desaturation occurring during recovery in more than 25% of all children given brief dental anaesthesia was of the same order of magnitude as that recorded by others during dental anaesthesia: 37.6% of 274 patients (table III). Although the median SpO2 was greater in those receiving supplementary oxygen (group 2), this did not affect the incidence of desaturation. In contrast, increasing the inspired oxygen concentration (FiO2) to 30% during anaesthesia reduced the duration and severity of desaturation compared with an FiO2 of 20 and 25% [4]. When the FiO2 was increased from 33% to 50%, clinically (but not statistically) significant difference in the incidence of desaturation occurred: 13 of 40 compared with seven of 40, respectively [6].

Irrespective of 100% supplementary oxygen, desaturation is probably more likely to occur in the postoperative phase [6]. Airway obstruction may be detected readily by observation on the reservoir bag during anaesthesia, particularly when desaturation is likely to occur—on induction, mask application, insertion of the prop and during dental extractions [3, 7]. After operation, airway obstruction may be more difficult to detect because of the lateral position of the child, the presence of large oral packs, and (usually) a poor fitting face mask. Eleven of 80 (13.8%) children experienced significant desaturation after operation in Allen's study [6], compared with 32 of 120 (27%) in the present study, but the type of recovery staff involved was not specified in the earlier study. If oxygen 5 litre min⁻¹ was given to all children until awake (an average of 7 min in this study) and provided there were no wastage, one full F size cylinder should provide sufficient oxygen for 37 children. Given that about 4200 children are given outpatient dental anaesthetics each year in this unit, between two and three replacement oxygen cylinders should theoretically be required each week.

This study may be criticized on several grounds. Neither the observer nor the recovery nurse was "blind" to the administration of oxygen. Alternate allocation to each group is less ideal than random allocation, but did ensure equal numbers in both groups; furthermore, as not every child available for study was studied, predicting an individual's allocation to air or oxygen would have been difficult.

The duration of desaturation was not timed as the study examined the incidence of desaturation rather than the severity of desaturation (as judged by duration); previous experience indicates that episodes of desaturation are brief [3, 8]. Although no data were obtained on peroperative SpO2, the median starting SpO2 was the same in both groups and no different from that reported following general surgery in children [9].

Hypoxia has been recognized as the major threat to life in dental anaesthesia, and a "statistically significant association between death occurring as a result of a circulatory disorder and the recovery phase of the anaesthetic" has been noted [10]. The large retrospective study of deaths associated with dentistry between 1970 and 1979 noted that recovery from general anaesthesia was a particularly vulnerable period, but concluded that sudden collapse during recovery was caused more commonly by cardiovascular than respiratory causes [1]. However, the data from both these studies anodated pulse oximetry and the subsequent widespread recognition that significant hypoxia is commonly not detected clinically. In addition, a drowsy patient is probably more likely to suffer airway obstruction if not nursed during the recovery period in the lateral position by experienced staff. Given that postoperative desaturation is so common, it may contribute to
"circulatory disorders" [1] which in rare instances ultimately result in death following dental anaesthesia.

The present study contradicts the widely held belief referred to in the Poswillo Report [11] "that the transient nature of most dental anaesthetics argues for simple clinical observation and against sophisticated, potentially frightening and time-consuming monitoring aids". The report goes on to say: "We therefore accept that the final decision of the level of monitoring in each individual case must be a matter for clinical judgement. However, patient safety must not be compromised." The pulse oximeter, already recommended during anaesthesia [7, 11, 12], should be available in the recovery period as well [11]. It might also help train individuals to maintain and protect the airway, and "recognise, diagnose and apply appropriate resuscitatory measures without delay" [11, 13].

REFERENCES