Comparison of three devices for oxygen administration in the late postoperative period

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Summary
We have evaluated three different devices for oxygen administration in the surgical ward, the Hudson face mask (oxygen 3 litre min⁻¹, air 12 litre min⁻¹), the nasal prong (oxygen 3 litre min⁻¹) and the binasal catheter (oxygen 3 litre min⁻¹). We evaluated the three devices in random order for periods of 30 min each in 25 patients with postoperative hypoxaemia (SpO₂ < 94%). Arterial oxygen saturation was measured by continuous pulse oximetry and comfort was evaluated with a questionnaire after each treatment period. The three systems increased arterial oxygen saturation to similar levels, but the highest degree of comfort was found with the binasal catheter. Use of the binasal catheter is recommended for oxygen administration in the late postoperative period. (Br. J. Anaesth. 1995; 74:607-609)

Key words
Hypoxaemia. Oxygen, therapy.

Arterial hypoxaemia is common as a constant or episodic phenomenon in the late postoperative period and it may be involved in the pathogenesis of postoperative morbidity and mortality [1]. It has been suggested recently that prolonged oxygen therapy may be indicated in the late postoperative period in the surgical ward [2], but there is only one controlled study on choice of device and doses of oxygen treatment after the first postoperative day [3]. This study showed that postoperative oxygen therapy with 37% oxygen by face mask increased mean oxygen saturation compared with placebo, but the study did not compare different methods of oxygen administration [3]. The aim of the present study was therefore to compare three variable performance devices for oxygen therapy in the late postoperative period.

Methods and results
We have examined three different devices: the Hudson face mask (with ties around the head), the nasal prong with foam collar and the binasal catheter. We studied 25 patients (nine men, median age 70 (range 39–88) yr, weight 63 (38–83) kg, height 167 (152–180) cm) in the ward after major abdominal surgery. Patients were studied between the second and fourth day (median 2, range 2–4) after laparotomy (11 patients underwent colonic resection, six gastric procedures, one splenectomy, five laparotomies for ileus caused by adhesions and two explorative laparotomies). The anaesthetic technique was inhalation (15 patients enflurane, 8 isoflurane) or i.v. (two patients midazolam–low-dose fentanyl). The patients were included in the study if arterial oxygen saturation (SpO₂) was < 94%, found by screening in the ward on the second, third and fourth postoperative days with a portable pulse oximeter (N-20, Nellcor Inc., Pleasanton, CA, USA). None of the patients had clinical signs of hypoxaemia or had received oxygen therapy before the study other than for 2–4 h in the immediate postoperative period in the recovery room.

The study consisted of three parts: (1) the patient received non-humidified oxygen 3 litre min⁻¹ by nasal prong for 30 min; (2) non-humidified oxygen 3 litre min⁻¹ by binasal catheter for 30 min; (3) oxygen 3 litre min⁻¹ and air 12 litre min⁻¹, humidified, by Hudson face mask for 30 min. Periods 1–3 were randomly reversed. During all periods, oxygen saturation was measured by continuous pulse oximetry (N-200, Nellcor Inc., Pleasanton, CA, USA, adhesive fingerprobe) and data were sampled into a bedside personal computer. Periods 1–3 were separated by pauses of approximately 10-min duration with no oxygen treatment. In these pauses the patient answered questions (see below) and the devices were changed. With every new period the patient breathed through the new device with supplementary oxygen for about 5 min before data sampling began. All data from the 30-min periods were used for data analyses.

After each period and before the beginning of a new period, the patient answered four questions: (1) Does this method of oxygen treatment restrict your movement in bed? (2) Does this method restrict you in eating or drinking? (3) Does this method cause discomfort in your airways? (4) Does this method give you discomfort or pain in the nose or ears?

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Thereafter, the patient gave an overall satisfaction score using a visual analogue scale (VAS score, 0 mm = worst possible discomfort, 100 mm = very comfortable). Finally, after trying all three systems, an overall preference (ranked one, two or three) was obtained.

The study was approved by the local Ethics Committee and patients gave informed consent. Group data are given as median (range). For statistical analyses we used Friedman’s analysis of variance, the Wilcoxon signed rank test and the Fisher exact test. P < 0.05 was considered statistically significant.

Duration of surgery was 150 (42–285) min. At inclusion, median arterial oxygen saturation (SpO₂) was 91% (76–94%) when patients were breathing room air. During oxygen treatment SpO₂ increased to 97% (93–100%) using the nasal prong (P < 0.0001), to 97% (88–100%) using the binasal catheter (P < 0.0001) and to 97% (91–100%) using the Hudson face mask (P < 0.0001). There was no significant difference in oxygenation using the two nasal catheters (P = 0.9), but oxygen saturation was slightly lower with the Hudson face mask compared with the binasal catheter (P < 0.03) and nasal prong (P < 0.03) (Friedman’s analysis, P < 0.03).

All patients were able to rank the devices in order of overall comfort. Eighteen of the patients (72%) found the binasal catheter to be the most comfortable method for oxygen treatment, while seven patients (28%) preferred the nasal prong. Twenty-two patients (88%) gave the Hudson face mask the lowest rank.

VAS score for comfort for the binasal catheter was 85 (48–100) mm, for the nasal prong 72 (19–100) mm and for the Hudson mask 42 (0–94) mm. According to the VAS scores, patients preferred the binasal catheter to the nasal prong (P < 0.02) and the Hudson face mask (P < 0.0001) (Friedman’s analysis, P < 0.0001).

The answers to the four additional questions (table 1) showed that the binasal catheter had the highest number of “no” answers (implying better patient compliance) compared with the two other methods (81 “no” answers with the binasal catheter vs 58 “no” answers with the nasal prong (P < 0.001), and 31 “no” answers with the Hudson face mask (P < 0.001)). The main problem with the Hudson face mask was difficulty in eating and drinking (table 1).

**Comment**

The basic finding of our study was that the three methods of oxygen treatment increased arterial oxygen saturation to comparable levels, but patients preferred the binasal catheter to the nasal prong and Hudson face mask.

The inspired oxygen concentration achieved with the three variable performance devices is a complex function of the geometry of the device, the oxygen flow rate and the patient's ventilatory pattern. We chose these three devices and oxygen doses simply because they represent the usual routine in our department. There are no studies available to distinguish between the efficacy of different doses and devices for oxygen therapy in the late postoperative period.

Nolan, Winyard and Goldhill used video surveillance on the first postoperative night to demonstrate that the face mask was removed frequently (for several hours in some patients) for various reasons, including routine nursing tasks, and that a nasal cannula was less likely to be removed than the mask [4]. Treatment with oxygen 2 litre min⁻¹ with the nasal cannula gave a similar increase in SpO₂ compared with oxygen 4 litre min⁻¹ by face mask [4].

Our findings of a higher degree of comfort and satisfaction with the binasal catheter and nasal prong compared with the Hudson face mask may explain the decreased patient compliance with the face mask demonstrated by Nolan, Winyard and Goldhill [4].

Studies from the immediate postoperative period in the recovery room have shown similar arterial oxygenation with 40% oxygen by face mask compared with oxygen 4 litre min⁻¹ by nasal catheter [5], and with oxygen 4 litre min⁻¹ by face mask compared with oxygen 2 litre min⁻¹ by binasal catheter [4]. Another study found that all patients had an arterial oxygen tension greater than 10 kPa when treated with oxygen by nasal catheter 3 litre min⁻¹ or 8 litre min⁻¹, respectively [6]. No such data are available from the late postoperative period.

Our results suggest that the binasal catheter should be used for supplementary oxygen therapy in the late postoperative period in the surgical ward when a variable performance device is indicated.

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**References**

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