

Accuracy of inpatient oxygen administration

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ABSTRACT The accuracy of supplemental oxygen delivery was assessed in two medical units. Only 90 of 206 patients (44%) were receiving oxygen as prescribed. The ward oxygen rotameters were inaccurate at normal clinical flow rates, the range of flows being delivered as a percentage of the indicated flow varying from 15% at 8 l/min to 40% at 1 and 2 l/min.

Introduction

Oxygen is widely prescribed. The inspired oxygen concentration may be critical for patients with hypercapnia and hypoxaemia^{1,2} and oxygen should therefore be prescribed and delivered accurately. We have studied the accuracy of oxygen prescription and delivery and the variability of flow rates from the ward oxygen rotameters in two respiratory units.

Methods

The study took place in two respiratory units (total 95 beds) in the City Hospital, Edinburgh, where all oxygen must be prescribed. The prescription sheet of each patient was checked and every patient in the ward who had been prescribed or was receiving supplemental oxygen was included in the survey. Prescription details, the set oxygen flow rate, and the adequacy of position of the delivery device on the patient's face were recorded. Each unit was assessed 15 times, at 9 and 11 am and at 6 and 9 pm on three occasions each in random order, without prior notification of ward staff. The visits were separated by at least two days and spread over two months. Ward staff were told only that we were checking on patient compliance.

Our standard ward oxygen rotameter (Oxylite F1600, range 0-14 l/min) is set by aligning the centre of a floating ball with calibration marks on the device. The accuracy of 15 randomly selected meters was measured by connecting them to a precision 0-10 l/min rotameter (Rotameter Manufacturing Co), calibrated against a Tissot water sealed spirometer. The ward flow meters were set to 1, 2, 4, 6, and 8 l/min

and flow on the standard rotameter was recorded. All measurements were made in daylight within 4 hours by one investigator with the meters connected to the ward piped oxygen points.

Results

Overall, 25% (206 out of 819) inpatients had been prescribed or were receiving oxygen at the times of study. Six were receiving oxygen via a mask and the rest had nasal prongs either prescribed or in use. Ninety of the 206 patients eligible for study (44%) were receiving the oxygen as prescribed. The sources of error among the others are given in the table. All patients receiving oxygen that had not been prescribed were receiving 2 l/min or less by nasal cannula. Three patients had been prescribed Venturi masks and were using nasal cannulae.

The median gas flows measured were close to those indicated, but the ranges were large (figure). For example, at a setting of 2 l/min the flows recorded ranged from 1.6 to 2.4 l/min. The range, as a percentage of indicated flow ($[\text{highest} - \text{lowest}] \div \text{indicated}$), varied from 15% at 8 l/min to 40% at 1 and 2 l/min.

Discussion

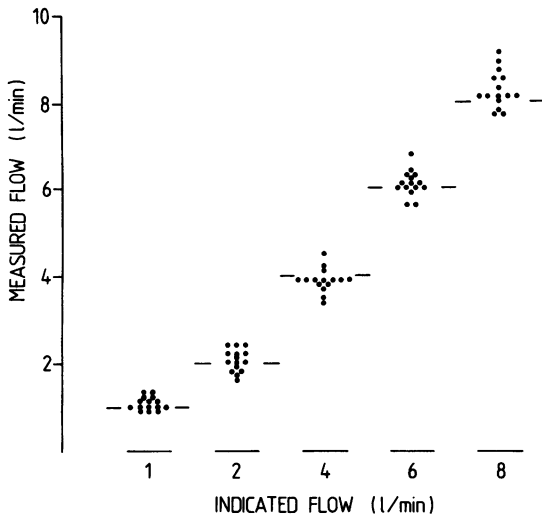
Although hospital policy is that oxygen must be

Distribution of faults among the patients prescribed or receiving supplementary oxygen

	No of patients
Oxygen switched off	44
Wrong flow rate (> 1 l/min)	28
No prescription	24
Mask off face	17
Wrong method	3
Correct	90
Total	206

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Measured oxygen flow rates shown against the indicated flows. The horizontal bar marks the indicated flow in each case.

prescribed before being administered, we found that only 44% of patients received the oxygen as prescribed. Even when we allow for the inaccuracy of the flow meters, few received the oxygen prescribed. On some occasions patients may not have been receiving their prescribed oxygen because a verbal order to discontinue oxygen therapy preceded cancellation of the prescription. Even in the patients with an oxygen meter switched on, however, one in five had an incorrectly set flow rate and one in eight were not wearing nasal prongs. The standard oxygen flow rates used with nasal prongs are 1 and 2 l/min.^{3,4} To set a standard 0–14 l/min rotameter to these levels requires delicate adjustment. If it is knocked or a curtain brushes against the control the setting is easily changed, and this may account for some of the observed inaccuracies. Although, on average, flow meters delivered the correct flow, there was considerable variation in flow meter performance at the flow rates commonly used. The oxygen flow rate delivered to a patient via nasal prongs at 2 l/min may change from 1.6 to 2.4 l/min if the patient simply changes bed. We were able to test two BOC (British Oxygen

Company) 0–15 l/min units and we found these to give broadly similar results.

We did not assess the clinical importance of the discrepancies between prescribed and received oxygen in individual cases to avoid alerting the medical and nursing staff to the purpose of the study. In patients with carbon dioxide retention a small increase in inspired oxygen concentration may lead to a substantial increase in hypercapnia and respiratory acidosis, with serious consequences. Masks working on the Venturi principle remain acceptably accurate in the delivery of low concentrations of oxygen over a range of flow rates.⁵ Our findings imply that such masks might be used in preference to nasal prongs in hypercapnic patients if compliance with such masks is adequate. We had hoped to investigate this but too few patients were using masks to allow us to assess whether compliance was better than with nasal prongs.

The training of nursing and medical staff in the prescription and delivery of oxygen therapy should be improved, and more accurate systems for delivering low flow rates of oxygen to inpatients should be developed.

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