Oxygen prescription and administration at the Emergency Department and medical wards in Mater Dei Hospital

Rachelle Asciak, Valerie Anne Fenech, Jurgen Gatt, Stephen Montefort

Abstract

Aims: The aim of this study was to audit current practices on oxygen prescription in the Emergency Department (ED), and on accurate oxygen administration in the wards of Mater Dei Hospital.

***Method*:** Two hundred and forty eight adult patients attending the ED with diagnoses most likely to require oxygen therapy (mainly cardio-respiratory conditions) were randomly selected during 5 winter weeks. Data were collected on oxygen saturation, arterial blood gases, oxygen administration at the ED, oxygen prescription and its documentation, and oxygen administration in wards. The *z*-test was used to assess statistical significance of results and Fisher's exact test was used to determine the effect of oxygen prescription documentation in treatment charts.

Results: Oxygen treatment was indicated in 85 of the 248 patients. Of these, documented oxygen administration at the ED was only present in 23.5% ($p<0.0001$). Formal instructions on oxygen use were documented in 85.9% ($p<0.0001$), however in 51.8% of these there were incomplete details. Only 7.1% of patients in whom oxygen treatment was prescribed received oxygen therapy in the wards according to instructions ($p<0.0001$). It was also found that documenting oxygen prescription in treatment charts made no significant difference to the number of patients who actually received oxygen correctly in the ward.

***Conclusion*:** This study shows that there is need for better prescription, documentation and administration of oxygen in our hospital. Introduction of simple standardized oxygen charts may ensure that oxygen prescription and monitoring in the ED is carried out properly and that these instructions are then faithfully carried out in our wards.

Keywords

Oxygen, documentation, prescription, audit

Rachelle Asciak* MD
Email: rachasciak@gmail.com

Valerie Anne Fenech MD MRCP
Dept of Medicine, Mater Dei Hospital, Msida, Malta
Email: valerie-anne.a.fenech@gov.mt

Jurgen Gatt MD
Dept of Medicine, Mater Dei Hospital, Msida, Malta
Email: jurgen.gatt@gov.mt

Stephen Montefort MD, PhD
Dept of Medicine, Mater Dei Hospital, Msida, Malta
Email: stevemonte@waldonet.net.mt

** corresponding author*

Introduction

Oxygen is a very commonly used therapeutic agent and is the treatment for hypoxaemia. According to the Oxygen Administration Guidelines issued by the British Thoracic Society in *Thorax* 2008, supplemental oxygen is indicated if oxygen saturation is <94%, or <88% in Chronic Obstructive Airways Disease (COAD) patients, and target oxygen saturation on pulse oximetry (SpO_2) in the normal population is 94-98%, or 88-92% in COAD patients.[1]

Both hypoxia and hyperoxia may be harmful. Severe hypoxia can cause pulmonary vasoconstriction and subsequent pulmonary hypertension, coronary vasodilatation and subsequent myocardial ischaemia, tachycardia, lactic acidosis, acute tubular necrosis, vasodilatation with increased cerebral blood flow and subsequent confusion and coma.[1] Acute hypoxia is considered to be dangerous when partial pressure of oxygen (PaO_2) is <45mmHg and oxygen saturation on arterial blood gas measurement (SaO_2) is <80%, because of impaired mental function and risk of tissue hypoxia. Consciousness is lost at a PaO_2 of <30mmHg and SaO_2 <56%. In patients with acute illness or preceding organ ischaemia, the danger is likely to be present at higher oxygen levels.[1] Furthermore, patients with sustained desaturation levels of <90% have decreased medium-term survival.

Hyperoxia on the other hand may lead to decreased ventilation and worsened ventilation-perfusion (V/Q) mismatch, decreased haematocrit with subsequent myocardial ischaemia, increase in peripheral vascular resistance and blood pressure, decreased renal blood flow, absorption atelectasis, and increased oxygen free radicals. It may also cause a delay in recognition of clinical deterioration, worse outcomes in cerebrovascular attack, and may be harmful in patients at risk of hypercapnoeic respiratory failure, as in COAD patients.[1] High concentration of oxygen in patients with coronary heart disease may actually reduce mean coronary blood flow by 7.9% to 28.9%, a phenomenon that may in fact potentiate myocardial ischaemia. Oxygen therapy in uncomplicated myocardial infarction (MI) can lead to a greater infarct size and may possibly increase mortality.[2, 3, 4]

In patients at risk of Type 2 (hypercapnoeic) respiratory failure such as COAD patients it is advisable to start off with 28% Venturi mask at 2-4 L/min oxygen, with target SpO_2 88-92% pending availability of blood gas results.[1, 5, 6]

However although all these important facts are well-known to our doctors and nurses, there seem to be a lot of shortcomings when they actually prescribe, document, instruct and monitor the use of oxygen therapy.

The aim of this study was to audit current local practices and identify areas for improvement. It also tested the hypothesis that documenting prescribed oxygen in treatment charts has an effect on correct oxygen administration in wards.

Methods

The audit was conducted between the third of March and the fifth of April 2010, as during this winter period there are likely to be several presentations to the ED with cardiovascular and respiratory conditions. A roster for data collection was set up for the doctors involved in this audit according to their availability. This included afternoons and nights, on both weekdays and weekends. Over these 5 weeks, three doctors prospectively and randomly selected 248 adult patients, over the age of 16 years, who were admitted to Mater Dei Hospital with medical conditions most likely to require oxygen treatment. This included cardiovascular and respiratory conditions, cerebrovascular attacks and transient ischaemic attacks, loss of consciousness, deterioration in general condition and confusion. Data were collected from the ED sheets, results of SpO_2 and arterial blood gases (ABGs) including SaO_2. Details of oxygen delivery and written instructions about oxygen prescription, if at all present, were noted. Within the first 24 hours following admission the patients were then followed up to the wards to look at the treatment chart to check documentation of oxygen prescription, and to see if oxygen treatment was being administered as prescribed. The data collection sheet used is shown in Figure 1.

Patients being admitted to intensive care unit or on non-invasive ventilation were excluded, as were patients admitted by the medical firms in which the doctors involved in this study were working with, in order to avoid bias. All ward personnel other than the authors were unaware of the audit. Patients who were admitted during the morning hours, when they were likely to be reviewed by the firm within a short time, were excluded as the firm may have changed oxygen prescription and administration themselves, soon after.

A total of 248 patients were included. Oxygen was said to be indicated if SpO_2/SaO_2 on air was <94% (or <88% in COAD patients). Where both SaO_2 from ABG results, and SpO_2 from pulse oximetry, were available on air, the lower value was used.

Statistical analysis

The statistical significance of the results obtained was calculated using the *z*-test to compare two proportions. The statistical significance of the hypothesis that documenting prescribed oxygen in treatment charts has an effect on oxygen administration in wards was measured using Fisher's exact test because the numbers involved were too small for Chi square test to be used.

Consent

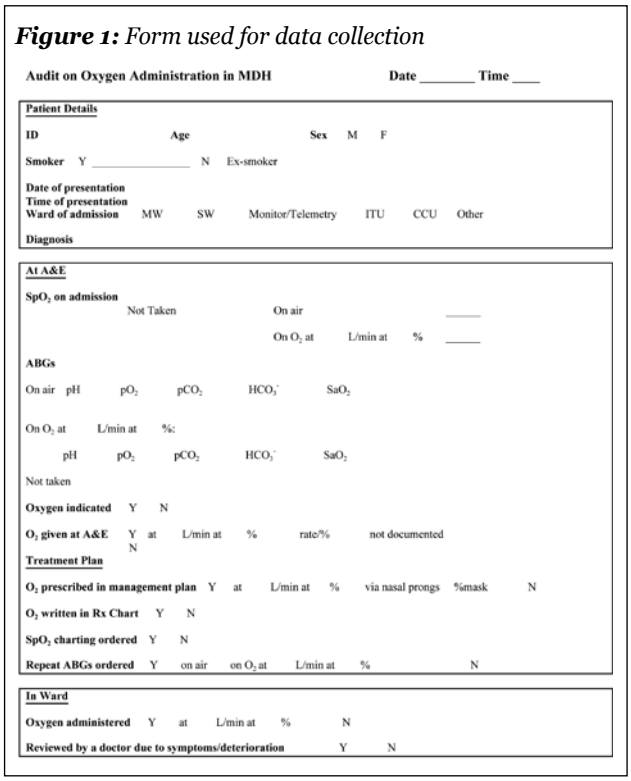
Consent was obtained from General Medical specialties Consultant physicians to use the notes of patients admitted under their care in the audit, all data being anonymous.

Results

Diagnoses

Using the Oxygen Administration Guidelines [1], oxygen was said to be indicated if SpO_2 on air was <94%, or <88% in COAD patients. According to this, oxygen administration was indicated

Figure 1: *Form used for data collection*



Audit on Oxygen Administration in MDH **Date _____ Time ____**

Patient Details

ID **Age** **Sex** M F

Smoker Y _____ N Ex-smoker

Date of presentation
Time of presentation
Ward of admission MW SW Monitor/Telemetry ITU CCU Other

Diagnosis

At A&E

SpO_2 on admission
Not Taken On air _____
On O_2 at L/min at % _____

ABGs

On air pH pO_2 pCO_2 HCO_3^- SaO_2

On O_2 at L/min at %:
pH pO_2 pCO_2 HCO_3^- SaO_2

Not taken

Oxygen indicated Y N

O_2 given at A&E Y at L/min at % rate/% not documented
N

Treatment Plan

O_2 prescribed in management plan Y at L/min at % via nasal prongs %mask N

O_2 written in Rx Chart Y N

SpO_2 charting ordered Y N

Repeat ABGs ordered Y on air on O_2 at L/min at % N

In Ward

Oxygen administered Y at L/min at % N

Reviewed by a doctor due to symptoms/deterioration Y N

in 85 patients (34.3%) of the total 248 included in this audit. Table 1 shows the conditions which were considered to be the most likely to require supplemental oxygen therapy.

Oxygen saturation documentation

Of the 248 patients included in this audit, 18 patients (7.3%), had no documentation of SpO_2 or SaO_2 on admission, so oxygen indication could not be determined. There were a further 17 patients (6.8%) in whom oxygen saturation was available only after the patient had been started on oxygen. In 41 patients (16.5%) there was documentation of SpO_2 both on air and on oxygen. Where SpO_2 was available on oxygen, 40 out of 58 patients (69.0%) had no documentation of flow rate and percentage of oxygen administration at which that SpO_2 was taken.

Arterial blood gases

ABG measurements were taken in 232 of the 248 patients. These values are shown in Table 2, together with the number and percentage of patients in whom oxygen was indicated. There were a number of patients in whom PaO_2 was low, however these did not show up as patients in whom oxygen was indicated as oxygen saturations measured were normal.

Documentation of prescription of oxygen, and oxygen administration

Table 3 shows the outcome of oxygen prescription and treatment in the 85 patients in whom oxygen treatment was indicated. Patients who had incomplete documentation of the flow rate and percentage of oxygen prescribed were classified together with the incorrectly administered oxygen treatment group, as it was not possible to determine whether oxygen was being received as prescribed or not.

The *p* values for the results in Table 3 were calculated using *z*-test for comparing 2 proportions, using a 95% Confidence level. The *z* values were then converted to *p* values.

Documentation of oxygen prescription in the Treatment Chart currently used

A comparison was made of patients in whom oxygen was prescribed and documented in treatment chart, with patients in whom oxygen treatment was prescribed in the management plan but *not* documented in the treatment chart. These are shown in Tables 4 and 5.

The statistical significance of the effect of documenting oxygen in treatment chart was calculated using Fisher's exact test because some numbers were too small to use Chi square test, and the R statistical package was used. The patients who were on nebuliser treatment when oxygen administration was being assessed were excluded from the calculation.

The result was a *p* value of 0.793 meaning that documentation of prescribed oxygen treatment made no statistically significant difference on the administration of oxygen. When comparing Table 4 to Table 5, the percentages are similar, so the sample size is unlikely to have had an effect on the result.

Discussion

This audit revealed that the main indications for oxygen therapy in the randomly selected patients participating in this study were acute exacerbations of congestive heart failure and asthma together with lower respiratory infections such as

Table 1: *Number and percentage of patients with the different diagnoses, the percentage of patients in whom SpO_2 was taken on admission, and the percentage of patients in whom oxygen treatment was indicated*

Main Diagnosis	No. of patients	% of total patients seen (248 patients in total)	% of patients in whom SpO_2 was taken on admission	% of patients in whom O_2 was indicated (ie. SpO2 air <94% or <88% in COAD patients)
CVA / TIA	27	10.9	81.5	7.4
ACS	36	14.5	80.6	23.5
CHF	74	29.8	97.3	52.7
Arrhythmias	19	7.7	100.0	15.8
Asthma	10	4.0	100.0	50.0
COAD	17	6.9	100.0	5.9
Pneumonia / Bronchitis	37	1.0	97.3	56.8
Pleural effusion	6	2.4	100.0	33.3
Pulmonary Fibrosis	2	0.8	100.0	100.0
Lung Malignancy	2	0.8	100.0	0.0
PE	1	0.4	100.0	0.0
Deterioration in General Condition/Confusion	5	2.0	80.0	40.0
SOB	8	3.2	87.5	50.0
LOC	4	1.6	100.0	0.0

CVA: Cerebrovascular Attack, TIA: Transient Ischaemic Attack, ACS: Acute Coronary Syndrome, CHF: Congestive Heart Failure, COAD: Chronic Obstructive Airways Disease, PE: Pulmonary Embolus, SOB: Shortness of Breath, LOC: loss of consciousness.

acute bronchitis and pneumonias. The decision regarding the need and safety of using oxygen in these patients depended mostly on oxygen saturation obtained by pulse oximetry or arterial blood gases, as should be the case. However a number of patients were still given oxygen without any sort of reported clinical or physiological reason for doing so. Although oxygen saturation was measured in most patients there was often no documentation as to whether this measurement was taken while the patient was on oxygen or not. When it was, the flow rate or concentration of oxygen supply was missing in most cases. This obviously hinders any precise monitoring of the real need of oxygen and whether the patient's hypoxaemia was actually improving or not, especially during the patient's early stages of treatment. In this audit arterial hypoxaemia and/or hypercapnoea were shown to play a role in the initiation of controlled oxygen therapy in a good number of patients.

It was also demonstrated that there was a poor standard of documentation and prescription of oxygen by the admitting doctor in the majority of patients. Of the 85 patients in whom oxygen was indicated, oxygen was prescribed with mention of both oxygen concentration and flow-rate in only 34.1%. Not only that, but the prescribed oxygen was noted either only in the minority of management plans or only in treatment charts and hardly ever in both. In many instances when this was done, the details noted were incomplete. Very often the oxygen was prescribed as "Keep on oxygen" in the management plan, however no details were available on flow rate or percentage oxygen prescribed. This meant that once the patient was admitted to the ward, oxygen was just administered at random flow rates and usually with whatever mask the patient came up to ward from the ED with, be it a normal mask, Venturi, or non rebreather mask. All this could lead to over or under-treatment with oxygen, both of which could be detrimental and/or very

Table 2: *Arterial blood gas values and the number and percentage of patients in whom oxygen was indicated. NB in this study, oxygen saturation was used to determine indication of oxygen, rather than PaO_2*

	No. of patients	% of the 248 patients seen	% of patients in whom O_2 was indicated
PaO_2 <60mmHg	29	11.7	28.2
$PaCO_2$ >45mmHg	29	11.7	17.6
SaO_2 <94% or <88% in COAD patients	69	27.8	100

PaO_2: partial pressure of oxygen in arterial blood, $PaCO_2$: partial pressure of carbon dioxide in arterial blood, SaO_2: oxygen saturation in arterial blood

Table 3: *Number and percentage of patients in whom oxygen treatment was administered at the ED, in whom oxygen treatment was prescribed, documentation of the prescription of oxygen treatment, and administration of the oxygen treatment in the ward*

No. of patients	Oxygen administration at the ED (which was documented)	Oxygen treatment prescription	Documentation of oxygen treatment prescription				Administration of oxygen treatment in ward	
			In management plan only	In treatment chart	Both O2% and L/min documented	Incomplete details	Correctly, as prescribed	Incorrectly or not administered
85	20** (23.5%)	73** (85.9%)	29* (34.1%)	44 (51.8%)	29 (34.1%)	44 (51.8%)	6** (7.1%)	79 (92.9%)

*** p<0.0001, * p<0.02*

Table 4: *Oxygen administration in patients in whom oxygen was prescribed and documented in treatment chart*

	No of patients	%
Oxygen received as prescribed	5	7.0
Not on oxygen (excluding 1 4 patients in whom Oxygen was prescribed PRN)	32	45.1
Received oxygen incorrectly	20	28.2
Not enough details in management plan to be able to assess if patient was on correct oxygen treatment or not	14	19.7

Table 5: *Oxygen administration in patients in whom oxygen was prescribed but not documented in treatment chart.*

	No. of patients	%
Received oxygen treatment as prescribed	2	4.1
Not on oxygen treatment	17	34
Received oxygen treatment incorrectly	14	28.6
Not enough details in management plan to be able to assess if patient was on correct oxygen treatment or not	11	22.5
Oxygen prescribed as required (*prn*)	5	10.2

dangerous to these acutely ill patients. In fact in this study some patients (2.0%) were actually found to be on oxygen when there was no actual mention of oxygen prescription in the patients' file or treatment chart. Presumably these patients either went up to the ward from the ED still on oxygen which was inadvertently started in the acute situation and never removed, or the instructions to keep the patient on oxygen were given by word of mouth without any sort of documentation.

Unfortunately, there were only very few patients in whom oxygen treatment was indicated who actually received oxygen as prescribed. In fact even in those few patients where proper prescriptions and documented instructions on oxygen therapy were given, these instructions were not followed by the ward staff. Audits of oxygen use in other hospitals have also found that the quality of oxygen use was suboptimal.[7,8] One audit showed that only 8% of patients receiving oxygen had it prescribed in their medication chart, and in another oxygen prescriptions were found to be inadequate in 75%.[7] This compared well to the 51.8% of such patients reported in our audit. When taking into consideration the fact that there are an additional 14.1% in this audit in whom oxygen was indicated but not prescribed, the results are very poor indeed. Furthermore, we showed that SpO_2 monitoring and charting was ordered in only 10 of the 85 patients in whom oxygen was indicated (11.8%) thus leaving the clinician in the dark regarding any improvement or indeed any worsening in the patient's hypoxemia and/or hypercapnoea.

Even when proper documentation of oxygen in treatment charts was present there was no significant difference to the actual proper administration of oxygen in the ward. There is clear indication of a need for some instrument to make sure that these instructions are carried out.

Limitations of this study include the fact that a random number generator could have been used to select dates of review. Also, there were a few patients who were receiving nebulised treatment at the time data were collected on oxygen administration in the ward. These had to be excluded from the calculation on accuracy of oxygen administration. Finally, patients who had incomplete details in oxygen prescription were classified together with the incorrectly administered oxygen treatment group, as it was not possible to determine whether oxygen was being received as prescribed or not. This led to a possible over-estimation of incorrect oxygen administration.

Conclusion

Oxygen should be treated like any other drug with clear written instructions regarding the dose/concentration, duration and delivery system to be used. We feel that this study has met its aim of auditing current practices in oxygen administration and prescription in the ED and oxygen administration in the wards of our hospital. Based on the results obtained, we also feel that there is need for better prescription, documentation and administration of oxygen treatment.

According to the British Thoracic Society guidelines on emergency oxygen use, oxygen saturation should be among the five vital signs (together with blood pressure, pulse, temperature and respiratory rate) that should be measured, monitored and documented clearly on the ED sheet of any patient admitted into hospital.[1] This oxygen saturation together with the oxygen therapy prescribed should be continued to be charted and monitored once the patient is transferred to a ward. This study clearly shows that there are several shortcomings in our hospital where oxygen therapy administration, prescription, documentation and monitoring are concerned.

In addition arterial blood gases should be taken in all critically ill patients, patients with SpO_2 <94%, deterioration in a previously stable patient, acute dyspnoea in patients with risks for metabolic conditions, such as diabetic ketoacidosis and renal failure.[1]

We propose the introduction of oxygen administration guidelines into our hospital to aid doctors in prescribing oxygen. We also suggest the designing of a simple chart in which clear instructions at the ED and ward levels are written. Once these instructions are carried out, these have to be accompanied by signed affirmations of the nurses who followed these instructions. Records of monitoring of this oxygen therapy can then be added to make sure that this important mode of treatment in patients with acute cardiorespiratory failure is instituted in the appropriate fashion.

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