Original Article

The effect of a hospital oxygen therapy guideline on the prescription of oxygen therapy

Rachelle Asciak, Caroline Gouder, Maria Ciantar, Julia Tua, Valerie Anne Fenech, Stephen Montefort

Abstract

Aim: To assess the effect of a hospital oxygen therapy guideline on oxygen prescription and administration at the emergency Department (ED) and medical wards of Mater Dei Hospital, Malta.

Methods: Patients admitted to medical wards through the ED with conditions most likely to require oxygen therapy were recruited over 2 months in 2011. Data was collected on oxygen therapy prescription and administration. A hospital guideline on oxygen therapy was introduced and disseminated in 2015, following which data was collected again and compared to the 2011 data. A *p* value <0.05 was deemed to be statistically significant.

Results: 248 and 293 patients were recruited in 2011 and 2015 respectively. Oxygen therapy was indicated in 34.3% and 31.4% of patients respectively (p=0.47). Oxygen saturation on air was not documented in 14.1% (2011) and 4.4% (2015) (p<0.01).

In patients in whom oxygen therapy was indicated, correct documentation (including delivery device and flow rate) of oxygen therapy administered at ED improved from 23.5% to 73.9% (p<0.01), and correct oxygen therapy prescription in the management plan improved from 34.1% to 76.1% (p<0.01).

In the medical wards, correct oxygen therapy administration according to prescription improved from 7.1% to 48.9% (p<0.01).

56.8% of patients in whom oxygen therapy was not indicated were prescribed oxygen anyway in 2011, improving to 27.1% after the guideline (p<0.05).

Conclusion: Oxygen saturation, oxygen therapy prescription and documentation at the ED and oxygen therapy administration in the medical wards improved significantly at Mater Dei hospital, Malta, after a hospital guideline was introduced.

Key words

Oxygen, Oxygen prescription, Guideline, Oxygen therapy in hospital

Rachelle Asciak, MD, MRCP*
rachelle.asciak@gov.mt

Caroline Gouder, MD, MRCP

Maria Ciantar, MD

Julia Tua, MD

Valerie Anne Fenech, MD, MRCP

Stephen Montefort, MD, PhD

**Corresponding Authors*

Introduction

Oxygen therapy can be life saving, and oxygen is one of the most commonly prescribed drugs in Internal Medicine wards. Both hypoxia and hyperoxia can be harmful, and so great care must be taken to prescribe oxygen therapy correctly and only when it is indicated.

Aim

The aim was to document the effect of a local hospital oxygen therapy guideline on the prescription, documentation and administration of

supplemental oxygen within the emergency department and medical wards in Mater Dei Hospital, Malta.

Method

Patients admitted to medical wards through the emergency department, with conditions likely to require oxygen therapy were recruited in 2011.[1] Data was collected on oxygen therapy documented to have been administered at the emergency department, oxygen therapy prescribed for patients being admitted to medical wards and whether this was indicated or not based on oxygen saturation measurements documented, and actual administration of oxygen therapy once the patients reached the medical wards. The data was compared to the standards established by the British Thoracic Society (BTS) guideline for emergency oxygen use in adult patients.[2] Oxygen was said to be indicated if oxygen saturation from pulse oximetry (SpO_2) or oxygen saturation from arterial blood gas result (SaO_2) on air was <94% (or <88% in patients with, or at risk of, type two respiratory failure). Where both SaO_2 and SpO_2 were available on air, the lower value was used.

In July 2015, a local hospital oxygen therapy guideline was issued on the local hospital intranet and disseminated among all hospital employees. A further email was sent out in August 2015 specifically to emergency department doctors and doctors in the Internal medicine department. This email included a short summary of the pitfalls identified in oxygen therapy documentation and prescription as identified from our data collection in 2011, informed the doctors of the new guideline available, with the guideline attached to the email, and informed doctors that oxygen therapy would be audited.

The guideline contained information on the different types of oxygen delivery devices available in the hospital, and when each one is indicated, a flow chart on the use of oxygen therapy in emergencies, information on pulse oximetry measurements and documentation of the readings, oxygen therapy prescription and documentation, the risks of hyperoxaemia, conditions at risk of hypercapnic respiratory failure, and oxygen therapy administration and monitoring to ensure that the oxygen saturation is within the target range identified for each patient.

Data was then collected again in September 2015 using the same proforma used in 2011. Results were compared to those obtained in 2011,[1] before the guideline was issued. The Z-test was used to compare the proportions in the two populations and assess the statistical significance of results, and a p value of <0.05 was deemed to be statistically significant.

The patients were prospectively and randomly selected adult patients, over the age of 16 years, who were admitted to Mater Dei Hospital with medical conditions most likely to require oxygen treatment. These included cardiovascular and respiratory conditions, cerebrovascular attacks and transient ischaemic attacks, loss of consciousness, deterioration in general condition and confusion. Data was collected from the emergency department sheets, documented results of SpO_2 measurements by pulse oximetry, and documented 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 at the wards to document the oxygen prescription on the treatment chart, and to see if oxygen treatment was being administered as prescribed.

Patients being admitted to the intensive care unit were excluded.

'Complete' documentation was said to be present when oxygen therapy documentation or prescription contained full details including the oxygen delivery device (normal standard oxygen mask, Venturi mask, nasal prongs, or non-rebreather mask), and flow rate (not deemed to be necessary for Venturi masks as long as the percentage of oxygen concentration was specified, e.g. 28% Venturi mask).

Results

Documentation of oxygen saturation

There were 14.1% (n=35) of patients in 2011 who had no documentation of SpO_2 or SaO_2 on air so it was not possible to tell whether oxygen therapy was indicated or not in these cases. This improved to 4.4% (n=13) of patients in 2015 (p<0.01).

Oxygen therapy in patients in whom oxygen therapy was indicated

Table 1 shows the results obtained in the

group of patients in whom supplemental oxygen therapy was indicated. The results obtained before and after the guideline was introduced were compared. Oxygen therapy was indicated in 34.3% (*n*=85) in 2011, and 31.4% of patients (*n*=92) in 2015 (*p*=0.478, i.e. no statistically significant difference between the sizes of the two populations in whom oxygen therapy was indicated). In these patients, the correct documentation of oxygen therapy administered at the emergency department, i.e. including the delivery device used and the flow rate (where indicated), improved from 23.5% to 73.9% after the guideline was introduced (*p*<0.01). Correct oxygen therapy prescription in the management plan for these patients also improved from 34.1% to 76.1% (*p*<0.01). Oxygen therapy prescription in the treatment charts currently used in medical wards was 51.8% before the guideline and 58.7% after the introduction of the guideline (*p*=0.352).

In the medical wards, there was correct oxygen therapy administration according to prescription in 48.9% after the guideline, as compared to 7.1% before the guideline (*p*<0.01).

Table 1: *showing the results of oxygen therapy prescription, documentation and administration before (2011) and after (2015) the publication of the local hospital oxygen therapy guideline in patients in whom oxygen therapy was indicated, i.e. SpO_2 or SaO_2 <94%, or <88% in patients with, or at risk of, type two respiratory failure.*

In patients in whom oxygen therapy *was* indicated						
Year of data collection	**No. of patients in whom O_2* was indicated**	**O_2 administered at the ED** and documented correctly****	**O_2 prescribed correctly in management plan**	**Correct *** O_2 prescription documented in treatment chart**	**O_2 administered in ward**	
					Correctly as prescribed	**Incorrectly or not given at all**
2011 (before guideline)	85	23.5% (*n*=20)	34.1% (*n*=29)	51.8% (*n*=44)	7.1% (*n*=6)	92.9% (*n*=79)
2015 (after guideline)	92	73.9% (*n*=68)	76.1% (*n*=70)	58.7% (*n*=54)	48.9% (*n*=45****)	48.9% (*n*=45****)
		p<0.01	*p*<0.01	*p*=0.352	*p*<0.01	*p*<0.01

*0_2 = supplemental oxygen therapy
**ED = emergency department
***Correct = including both the delivery device *and* the flow rate (not deemed to be necessary for Venturi masks if the concentration of oxygen is specified)
****1 patient refused 0_2, and another patient had oxygen therapy prescribed only as required (PRN)

Table 2: *showing the results of oxygen therapy documentation, prescription and administration before (2011) and after (2015) the publication of the local hospital oxygen therapy guideline in patients in whom oxygen therapy was not indicated, i.e. SpO_2 or SaO_2 >94% on air, or >88% in patients with, or at risk of, type two respiratory failure (Y = yes, N = no)*

In patients in whom oxygen therapy was *not* indicated (*n*=132 in 2011, *n*=170 in 2015)							
Year of data collection	**Received oxygen therapy at the ED**		**Prescribed oxygen therapy in management plan**			**Received oxygen therapy in ward**	
	Y	**N (or not documented)**	**Y**	**N**	**PRN***	**Y**	**N**
2011 (before guideline)	23.5% (*n*=31)	76.5% (*n*=101)	56.8% (*n*=75)	37.1% (*n*=49)	6.1% (*n*= 8)	47.0% (*n*=62)	53.0% (*n*=70)
2015 (after guideline)	27.1% (*n*=46)	72.9% (*n*=124)	27.1% (*n*=46)	67.1% (*n*=114)	5.9% (*n*=10)	33.5% (*n*=57)	66.5% (*n*=113)
	p=0.478	*p*=0.478	*p*<0.01	*p*<0.01	*p*=0.952	*p*<0.01	*p*=0.018

*PRN = oxygen therapy prescribed only as required
**ED = emergency department

Oxygen therapy in patients in whom oxygen therapy was not indicated

Table 2 shows the results obtained in the group of patients in whom supplemental oxygen therapy was not indicated. The results obtained before and after the guideline was introduced were compared. There was no difference in the number of patients who were documented to have received oxygen therapy at the emergency department before and after the guideline (*p*=0.478). However, fewer of these patients were prescribed continuous oxygen in their management plans, that is 56.8% before the guideline compared to 27.1% after the guideline (*p*<0.01). Also, fewer of these patients actually received oxygen therapy once in the wards, 47.0% before the guideline, compared to 33.5% after the guideline (*p*<0.01).

Discussion

Oxygen therapy is frequently used. Both hypoxia and hyperoxia can be harmful, and so oxygen therapy requires an adequate, detailed prescription like any other prescribed medication. Hypoxia can cause sudden cardiorespiratory arrest and irreversible damage to vital organs. On the other hand, the effects of hyperoxia are controversial. Possible adverse effects of hyperoxia include the production of reactive oxygen species, leading to oxidative stress and resultant cellular necrosis and apoptosis; coronary artery vasoconstriction[3] with consequent reduced coronary blood flow potentially increasing infarct size; and life-threatening hypercapnoea in patients at risk of type two respiratory failure, especially in patients with acute exacerbation of chronic obstructive pulmonary disease (COPD) – nearly half of acute exacerbations of COPD are associated with hypercapnia. This increases the need for mechanical ventilation and risk of death.[4] In a randomized controlled trial, mortality was shown to increase with the delivery of high concentration oxygen in acute exacerbation of COPD (9% mortality) when compared with controlled oxygen therapy (4% mortality).[5] Randomized controlled trials have also shown that high concentrations of oxygen increase the risk of hypercapnia also in conditions not typically associated with type two respiratory failure, including asthma and pneumonia.[6-7] Excess oxygen therapy also causes patient discomfort, and increases healthcare costs.

In this audit, the documentation of oxygen saturation on air at the emergency department,

documentation of oxygen therapy given at the emergency department, prescription of oxygen therapy when indicated for inpatients, and actual administration of oxygen therapy according to prescription once the patients got to the wards, were identified as areas needing improvement. Inadequacy of oxygen prescription is common not just in Malta. In a multicentre nationwide audit in Portuguese Internal Medicine wards, only 11.6% of oxygen prescriptions stated all the required parameters.[8] An audit in the UK revealed that oxygen therapy prescription was accurate for only 7% of patients, and the most common omission was the oxygen flow rate.[9] Another audit in New Zealand revealed that 75% of oxygen therapy prescriptions were inadequate.[10]

In Mater Dei Hospital, Malta, after the local hospital guideline on oxygen therapy in adults was published, there were improvements in the documentation of oxygen saturation on air at the emergency department, documentation of oxygen therapy being given at the emergency department, the prescription of oxygen therapy in management plans of patients when oxygen therapy was indicated, and also improvement in the administration of oxygen therapy in the medical wards for patients in whom oxygen therapy was indicated. Also, fewer patients received oxygen therapy when it was not indicated.

The British Thoracic Society (BTS) emergency oxygen audits[11] showed similar improvements in oxygen therapy prescription and administration after the publication of the BTS guideline on emergency oxygen use. Prior to the guideline, oxygen was commonly used without prescription, and even if oxygen therapy was prescribed, it was rarely administered according to prescription. However, after the guideline was introduced, the proportion of patients with a prescription for oxygen therapy increased from 32% to 56%, compared to this audit's results of 34.1% before the local hospital guideline, increasing to 76.1% after the hospital guideline was introduced. In the BTS emergency oxygen audits, the proportion of patients receiving oxygen therapy via the correct oxygen delivery system increased from 47% to 59% after the guideline was published. In this audit, oxygen therapy administration according to prescription improved from 7.1% to 48.9% after the local guideline publication.

There was no statistically significant change in the number of patients who received oxygen therapy at the Emergency department when it was not actually indicated. We postulate that this may be a reflection of the fact that patients are in the early stages of care, and would still be in the process of being worked up, with the underlying diagnosis not yet evident, and the arterial blood gas measurements not yet available.

The local hospital guideline significantly improved oxygen therapy use in Mater Dei hospital. This is certainly positive and encouraging. However, although there was an improvement in the number of patients receiving oxygen therapy when indicated, there were still 48.9% of patients in whom oxygen was indicated who did not receive oxygen therapy at all, or received it incorrectly (i.e. not according to prescription). One reason for this may be that the hospital guideline was disseminated on the local hospital intranet to all hospital employees including doctors and nurses just once, while a separate email was then also sent out to all emergency and medicine department doctors personally, with the guideline itself attached to the email, and some further information about the guideline. Given that within the hospital, doctors are responsible for oxygen therapy prescription, while nurses usually administer the oxygen therapy, the fact that the dissemination of the guideline was focused more on the doctors may be one of the reasons why oxygen therapy administration still needs further improvement. Also, the local hospital guideline did not significantly increase the documentation of oxygen therapy prescription in the standard treatment chart currently in use in the medical wards. These treatment charts are for general drug prescription and do not include a specific area for oxygen therapy prescription. Treatment charts including a specific area for documentation of oxygen therapy prescription and oxygen saturation target range are being designed for use at Mater Dei hospital, and may help to further improve oxygen therapy prescription, and facilitate better administration of oxygen therapy by nurses in the wards.

Since there was a time lapse between the first data collection in 2011 before the introduction of the guideline, and the second data collection after the introduction of the guideline in 2015, another limitation of the audit was that the guideline itself might not be the only reason for the improvement in oxygen therapy prescription and documentation.

Another possible reason may be that trainee doctors in both departments may have been exposed to lectures including information on oxygen prescription too.

Conclusion

Documentation of oxygen therapy administered at the emergency department, prescription of oxygen therapy for patients being admitted to medical wards, and actual administration of oxygen therapy at Mater Dei Hospital needed to be improved.

The local hospital guideline, which was introduced in 2015, provided information and guidance on all these points.

Data collected after the guideline was introduced showed a significant improvement in the documentation of oxygen therapy given at the emergency department, correct prescription of oxygen therapy prescribed including essential details such as delivery device and flow rate where required, and correct administration of oxygen therapy according to prescription in the medical wards.

References

1. Asciak R, Fenech VA, Gatt J, Montefort S. Oxygen prescription and administration at the Emergency Department and medical wards in Mater Dei Hospital. Malta Med J. 2011;23(2):19-23.
2. O'Driscoll BR, Howard LS, Davison AG, on behalf of The British Thoracic Society. British Thoracic Society, Emergency oxygen guideline group. Guideline for emergency oxygen use in adult patients, Thorax 2008;63(suppl VI):vi1-vi68.
3. McNulty PH, King N, Scott S, Hartman G, McCann J, Kozak M, et al. Effects of supplemental oxygen administration on coronary blood flow in patients undergoing cardiac catheterization. Am J Physiol Heart Cir Physiol 2005;288(3):H1057-62.
4. Murphy R, Driscoll P, O'Driscoll R. Emergency oxygen therapy for the COPD patient. Emerg Med J 2001;18:333-9.
5. Austin MA, Wills KE, Blizzard L, Walters EH, Wood-Baker R. Effect of high flow oxygen on mortality in chronic obstructive pulmonary disease patients in prehospital setting: randomized controlled trial. BMJ 2010;341:c5462.
6. Perrin K, Wijesinghe M, Healy B, Wadsworth K, Bowditch R, Bibby S, et al. Randomised controlled trial of high concentration versus titrated oxygen therapy in severe exacerbations of asthma. Thorax 2011;66(11):937-41.
7. Wijesinghe M, Perrin K, Healy B, Weatherall M, Beasley R. Randomized controlled trial of high concentration oxygen in suspected community-acquired pneumonia. J R Soc Med 2012;105(5):208-216.
8. Neves JT, Lobão MJ; Grupo de trabalho EMO. Oxygen therapy multicentric study-a nationwide audit to oxygen therapy procedures in internal medicine wards. Rev Port Pneumol 2012;18(2):80-5.
9. Dodd ME, Kellet F, Davis A, Simpson JCG, Webb AK, Haworth CS, et al. Audit of oxygen prescribing before and after the introduction of a prescription chart. BMJ 2000;321(7265):864–5.
10. Boyle M, Wong J. Prescribing oxygen therapy. An audit of oxygen prescribing practices on medical wards at North Shore Hospital, Aukland, New Zealand. N Z Med J 2006;119(1238):U2080.
11. O'Driscoll BR, Howard LS, Bucknall C, Welham SA, Davison AG, on behalf of the British Thoracic Society. British Thoracic Society emergency oxygen audits. Thorax 2011;66:734-5.