



Original Article

Current practice of prescription and administration of oxygen therapy: An observational study at a single teaching hospital

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الملخص

أهداف البحث: ينبغي إعطاء العلاج بالأكسجين، الذي يشيع استخدامه سريريا، وفقا لوصفة طبية؛ غير أن أدلة متراكمة تشير إلى وجود درجة من سوء الممارسة الطبية في هذا المجال. هدفت هذه الدراسة إلى تقييم الممارسة الحالية لكتابة الوصفة واستخدام العلاج بالأكسجين.

طرق البحث: أُجريت هذه الدراسة الرصدية في مستشفى تعليمي في المنطقة الشرقية بالمملكة العربية السعودية. شملت جميع المرضى المنومين في الأجنحة العامة الذين كانوا يُعطون أكسجينا إضافيا. تم جمع البيانات الديموغرافية للمرضى وعناصر وصفات الأطباء من ملفات قسم الرعاية التنفسية ومن الملفات الطبية للمرضى. كما تم رصد إعطاء الأكسجين للمرضى المنومين ومطابقتها مع وصفات الأكسجين المسجلة في الملفات الطبية وملفات قسم الرعاية التنفسية.

النتائج: من بين 152 مريضا منوما، كان 21 منهم على أكسجين إضافي. وكان لـ 20 من بين هؤلاء، وصفة طبية مكتوبة في الملف الطبي، ولكن فقط 18 كان لديهم معلومات مسجلة في ملفات قسم الرعاية التنفسية. من بين خمسة عناصر لوصفات العلاج بالأكسجين، توفر 3 منها عند 30% من المرضى، بينما لم تتوفر سوى 2 منها لدى 70% من المرضى. تمت التوصية بوسيلة إيصال الأكسجين في جميع وصفات الأطباء، بينما تم تحديد معدل التدفق ونسبة الأكسجين المستنشوق في 30% فقط من الوصفات. من بين ستة مرضى كان لديهم تسجيل مكتوب لتشبع الشعيرات الدموية الطرفية بالأكسجين المستهدف، كان لدى 2 منهم قيمة خارجة عن النطاق المستهدف، وكان لدى 2 من 6 مرضى معدل تدفق مختلف عن المعدل المطلوب في الوصفة.

الاستنتاجات: كانت الممارسة الحالية لوصفة العلاج بالأكسجين وإعطائها دون المستوى الأمثل. هناك حاجة إلى إجراء تحقيقات ومراجعات وطنية فيما يتعلق بممارسة العلاج بالأكسجين لتحسين رعاية المرضى.

الكلمات المفتاحية: العلاج بالأكسجين؛ إعطاء الأكسجين؛ وصفة طبية؛ العلاج التنفسي

Abstract

Objectives: Oxygen therapy, commonly used clinically, should be administered according to the physician's prescription; however, accumulating evidence signals some degree of inaccuracy in this perspective. This study aimed to evaluate the current practice of prescription and administration of oxygen therapy.

Methods: This observational study was conducted at a teaching hospital in the Eastern province of KSA. All inpatients in general wards who were on supplemental oxygen (O₂) were included. Patient's demographic data and physician's prescription items were collected from patient medical charts and the respiratory care (RC) department charts. Oxygen administration to inpatients was monitored and matched with oxygen prescriptions recorded on the medical and RC charts.

Results: Among 152 inpatients, 21 were on supplemental O₂. Of these, 20 had written prescriptions in their medical charts, but only 18 had information recorded in the RC charts. Of the 5 items required by hospital guidelines for oxygen prescription, 30% of patients had 3 items; whereas 70% of patients had only 2 items. Mode of oxygen delivery was recommended in all physicians' prescriptions, but flow rate and FiO₂ were ordered in only 30% of prescriptions. Among the 6 patients with a written record of target SpO₂ range, 2 had a value outside of the target range and 2 of 6 patients had a flow rate that differed from the prescribed rate.

Conclusion: Current practice for oxygen therapy prescription and administration was suboptimal. Nationwide investigations and remediations of oxygen therapy practice is needed to improve patient care.

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Keywords: Oxygen administration; Oxygen therapy; Prescription; Respiratory therapy

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Introduction

Medical oxygen is considered a drug that has beneficial effects at a safe dose and side effects at higher doses.¹ Oxygen therapy is commonly used to treat or prevent hypoxemia. It is also indicated in patients with traumatic brain injury, haemorrhagic shock, resuscitation during cardiac arrest, and carbon monoxide poisoning.² Published guidelines for in-hospital use of oxygen are available.^{3,4} Generally, the required amount of supplemental O₂ depends on the patient's condition. However, inappropriate prescription or administration of fraction of inspired oxygen (FiO₂) may have negative consequences.^{5,6} Therefore, oxygen should be prescribed and delivered correctly to ensure safe and effective oxygen therapy.

Earlier reports on oxygen prescription and administration have indicated poor results. One report from Edinburgh has indicated that only 43% of patients on supplemental O₂ received the prescribed therapy.⁷ Reports from New Zealand have indicated that one-third of patients received oxygen therapy that did not match prescription, and 75% of oxygen prescriptions were inadequate.⁸ Other reports have indicated that 28% of patients on oxygen therapy did not have physicians' orders,⁹ and only 11% of patients had oxygen prescription which fulfilled the in-hospital-use guideline.¹⁰ A report from England has indicated that only 16% of the patients received oxygen therapy that matched prescription.¹¹

In KSA, few investigations have evaluated oxygen prescription and administration. A considerable deficiency in oxygen prescription and administration was reported in 2002. However, while data regarding oxygen prescription and administration were collected, adequacy of oxygen prescription and administration was not evaluated.¹²

In 2008, the British Thoracic Society (BTS) first proposed standard practice guidelines for oxygen prescription and administration; subsequently, the guidelines were updated in 2017.^{13–15} Based on current guidelines, prescription should include the starting oxygen dose and oxygen delivery device, and most importantly, the oxygen saturation target range.¹³ An audit of oxygen therapy at UK hospitals during the period of 2008–2013 revealed that prescriptions with a target saturation range increased from 10% in 2008 to 52% in 2013, while, 45% of patients on oxygen therapy were without written orders.¹⁴

The purpose of the present study was to evaluate the practice of oxygen prescription and administration in the hospital's general wards with a primary focus on how well

oxygen prescriptions are completed according to hospital policy.

Materials and Methods

An observational study was conducted during 1 day at a large teaching hospital with 550 beds in the eastern province of KSA in April 2015. All inpatients in the general wards of the hospital were included. Inpatients on invasive or noninvasive mechanical ventilation were excluded.

The hospital policy for oxygen prescription and administration is based on the modified BTS guideline for oxygen prescription and administration. The modified guideline comprises 5 documented items in oxygen-therapy prescription, including 3 BTS-recommended items of targeted saturation, mode of delivery, and flow rate, and 2 additional items of FiO₂ and oxygen delivery rate in either continuous or intermittent mode. According to the hospital policy for oxygen therapy prescription and administration, all 5 items must appear on the physician's prescription. Therefore, a prescription containing all 5 items was considered a complete prescription.

All requests for supplemental oxygen therapy are commonly sent to the Respiratory Care (RC) Department where they are verified with the patient's medical chart; subsequently, the requests are printed on the RC oxygen therapy chart.

The list of all inpatients receiving oxygen therapy in the RC Department was checked. Patient characteristics including the patient's name, ward, bed number, gender, age, and diagnosis were collected; subsequently, the oxygen prescription was evaluated to determine whether the 5 items that constitute a complete oxygen therapy prescription were included. Based on the RC Department list, patients' medical charts were checked for availability and completeness of the oxygen therapy prescription. The patients' rooms were visited in-person by researchers for two purposes: first, to check whether oxygen was in use or not; second, to check whether the oxygen settings in use were in agreement with the oxygen therapy prescription on the patient's medical chart.

All inpatients in the male, female, and paediatric wards were checked to determine whether O₂ was in use or on standby. Medical charts for these patients were checked for the inclusion of an oxygen therapy prescription and the completeness of the prescription.

Finally, all inpatients on supplemental O₂ were checked through questionnaire including the following items: (1) Is oxygen saturation (SpO₂) monitored, and what is the observed value of SpO₂? (2) Is the SpO₂ value within target saturation range? (3) Is the oxygen delivery device the same as that prescribed, and appropriately fixed in place? (4) Is the flow rate set as prescribed? (5) Is the FiO₂ set as prescribed?

The study was approved by the hospital's ethics committee and the requirement for patient written informed consent was waived because the study was considered a service evaluation. Data were anonymized for the purpose of confidentiality by removing all identifying information.

Statistical analysis

Descriptive analyses were presented as absolute numbers and percentages for categorical variables, and mean and

standard deviation for continuous variables. Statistical analyses were performed using Microsoft Excel® 2017 (Microsoft Corporation, Redmond, WA, USA).

Results

On the day of the study, there were 154 inpatients in the male, female, and paediatric wards. Of these, 21 patients were on supplemental O₂. There were 14 male and 7 female and their age was on average 42 years. The patients on oxygen therapy had a variety of pathophysiology including post-traffic accidents, sickle cell disease, aspiration pneumonia, chronic obstructive pulmonary disease, and sepsis. Among the 21 patients on supplemental O₂, only one patient had no written oxygen therapy prescription in the medical chart; whereas, 3 patients had no written oxygen therapy prescription in the RC Department chart.

Number (%) of patients with a written oxygen therapy prescription on both the medical and RC Department charts are shown in Table 1. In total, 14% of all inpatients were on oxygen therapy, but only inpatients in the male wards had discrepancies between the medical and RC Department charts. Whereas 95% of patients on supplemental O₂ had

physicians' orders, only 85% had a prescription in the RC Department chart.

The completeness of the oxygen therapy prescription according to the hospital's criteria for physician prescription of oxygen therapy is shown in Table 2. In the results, none of the single prescriptions were complete; none of the physician oxygen therapy prescriptions had either 5 or 4 items; 30% of the physician oxygen therapy prescriptions had 3 items, while 70% of the physician orders had 2 items.

Discrepancy between the patient's medical chart and the RC Department chart in terms of completeness of oxygen therapy prescription is shown in Table 3. In the results, duration of O₂ use was not recorded in either the patient's medical chart or the RC Department chart; FiO₂ was requested in 70% of the physicians' orders, while the type of oxygen device was present in all of the physicians' orders. The targeted SpO₂ was requested in 30% of the physicians' orders, but in none of the RC department charts.

Observational findings on patients with supplemental oxygen therapy are shown in Table 4. Among 21 patients on supplemental O₂, only 3 had placement of a pulse oximeter to continuously monitor oxygen saturation. In total, 6 patients had a prescription for targeted oxygen saturation, of which, 4 patients attained SpO₂ within target range. Of the 20 patients

Table 1: Number of patients on oxygen therapy.

Ward	Total number	O ₂ prescription in medical chart	O ₂ prescription in RC Department chart	Actual number of patients on oxygen therapy
Male	93	11	9	12
Female	36	5	5	5
Paediatric	25	4	4	4
Total	154	20 (95) ^a	18 (86) ^a	21 (14) ^a

^a Percentage of 21 patients. RC, Respiratory Care.

Table 2: Completeness of physician oxygen therapy prescription according to hospital criteria.

Ward	Number of parameters						Total
	5	4	3	2	1	0	
Male	0	0	3	8	0	0	11
Female	0	0	1	4	0	0	5
Paediatric	0	0	2	2	0	0	4
Total	0 (0%)	0 (0%)	6 (30%)	14 (70%)	0 (0%)	0 (0%)	20

Table 3: Variation between patient medical charts and respiratory care charts.

Ward	Physician prescription					RC prescription						
	Written prescription	1	2	3	4	5	Written prescription	1	2	3	4	5
Male	11	3	11	3	8	0	9	0	9	1	8	0
Female	5	1	5	0	5	0	5	0	5	0	5	0
Paediatric	4	2	4	3	1	0	4	0	4	3	1	0
Total	20	6 (30)	20 (100)	6 (30)	14 (70)	0 (0)	18	0 (0)	18 (100)	4 (22)	14 (78)	0 (0)

1, Targeted saturation; 2, Mode of delivery; 3, Flow rate; 4, FiO₂; 5, Duration of prescribed oxygen. Data presented as number (%).RC, Respiratory Care.

Table 4: Observational findings in patients with oxygen therapy.

	Male ward	Female ward	Paediatric ward	Total
Monitored SpO ₂	1	0	2	3 out of 21
Written targeted SpO ₂	3	1	2	6 out of 20
SpO ₂ within targeted SpO ₂	2	1	1	4 out of 6
Prescribed O ₂ delivery device	11	5	4	20 out of 20
Observed O ₂ delivery device	10	5	3	18 out of 20
O ₂ delivery device appropriately fixed?	11	5	3	19 out of 21
Prescribed flow rate	3	0	3	6 out of 20
Flow rate same as that prescribed	2	0	2	4 out of 6
Prescribed FiO ₂	8	5	1	14 out of 20
Observed FiO ₂ in comparison to the prescribed value	4	5	1	10 out of 14

with a prescription for oxygen devices, 18 had the same device as prescribed; of the 6 patients with a prescription for flow rate, 4 patients had the same flow rate as prescribed, and of the 14 patients with a prescription for FiO₂ value, 4 had FiO₂ with different values from the value prescribed.

Discussion

The study data indicated that an oxygen prescription was present in the majority of patients' medical charts. However, none of the reviewed prescriptions for oxygen therapy were considered complete per the hospital's guideline: 30% of the prescriptions had 3 items, and the remaining 70% had only 2 items. Some (30%) of the prescriptions had target saturation and flow rate, while the majority (70%) of patients' medical charts had FiO₂ and all of the medical charts contained mode of delivery. Duration of oxygen therapy was absent in all prescriptions for oxygen therapy. Target saturation level was recommended in only 6 prescriptions, of which, the saturation level was not within target range in 2 cases. Flow rate was prescribed in 6 cases, of which, the prescribed value was attained in only 4 cases. FiO₂ was prescribed in 14 cases, of which, FiO₂ value differed from the prescribed value in only 4 cases.

The present data are comparable to those of previous studies. In our study, 14% of patients received supplemental O₂, which is similar to data obtained from UK hospitals of 15.5%, 13.7%, 14%, 13.8%, and 14% in 2010, 2011, 2012, 2013, and 2015 respectively.¹⁵ An audit of 180 UK hospitals in 2015 reported 7741 inpatients on supplemental O₂ with 52.7% of them having a prescription for oxygen therapy with target saturation, 4.8%, without target saturation, and 42.5% of the patients receiving oxygen therapy without written orders.¹⁵ Another study at a western Australian territory hospital found that almost 45% of patients on supplemental O₂ did not have a specified target range of SpO₂.¹⁶ Conversely, in Portugal where only 17.5% of patients with supplemental O₂ had a prescription with a specified target range, 82% of them achieved levels within target range.¹⁰ Our data revealed that only 30% of prescriptions for oxygen therapy included a target range for SpO₂, but 33% of those cases attained SpO₂ exceeding the target range, which is similar to results of a study on UK patients where 31% of the cases had SpO₂ outside the targeted range.¹⁵

The physician's recommended target range for SpO₂ is extremely important, but has received less attention than the oxygen delivery device that is routinely prescribed by physicians. Physicians' emphasis has focused on FiO₂, which is considered an important component of the prescription for oxygen therapy. Our data showed that 70% of patients had fixed FiO₂ in their prescription, which aligns with the study from Portugal where FiO₂ or flow rate was in 98% of prescriptions. In their study, the method of delivery was present in 80% of prescriptions for oxygen therapy.¹⁰ BTS and the western Australian hospitals recommend SpO₂ of 94–98% for patients *not* at risk for hypercapnic respiratory failure, and 88–92% for patients at risk of hypercapnic respiratory failure.^{4,17} Moreover, the findings from our study that oxygen therapy duration was not reported in all prescriptions, and SpO₂ monitoring was not performed in 86% of the cases are similar to those of the study in Portugal (85% and almost 71% of the cases, respectively).¹⁰ Absence of continuous or at least frequent SpO₂ monitoring may raise serious safety and efficacy issues,¹³ and in KSA, respiratory therapists (RTs) are responsible in this regard.^{18,19} RTs should frequently visit patients on supplemental O₂ and record the SpO₂; they should be allowed to independently adjust the FiO₂ or flow rate, and remind and encourage accurate completion of physicians' prescriptions for oxygen therapy.

The current data further support previous findings that oxygen prescription and administration practice is poor.^{20,21} This might be attributed to the underestimation of oxygen's potential therapeutic value and its side effects. The discrepancies in oxygen prescription and administration are not limited to certain geographical areas. It seems to be a globally recognized problem. Therefore, practical interventions may be required to improve the oxygen prescription and administration practice. For example, the development of a simple, specific oxygen prescription chart has markedly improved the rate and accuracy of oxygen prescription.²⁰ The oxygen prescription percentage increased from 55% to 91% after introduction of the oxygen prescription chart. Similarly, the accuracy and completeness of oxygen prescriptions increased from 7% to 77%. Our data has shown that policy and procedure guidelines (PPG) alone do not improve clinical practice. In terms of improving efficiency, the PPG needs to be monitored and enforced. In addition, a simple oxygen prescription chart may be used to remind and guide the physicians to accurately write complete oxygen prescriptions to ensure safe and effective practice.

Our study revealed some important overall results: First, there was variation in oxygen therapy prescriptions between the patient's medical chart and the RC chart, whereas, identical information between these records is expected. Multifactor variation sources may be present, and such variation would negatively impact the quality of patient's care. Early studies have shown that medication errors can happen at any stage: ordering, transcription, dispensing, and administration.^{22,23} Among these stages, transcription has been shown to have a high potential for errors.²² Errors in transcription may evolve from a discrepancy in the drug name, route, dose, dosing regime, omission of the drug, or an unordered drug.²³ Second, an incomplete oxygen therapy prescription may lead to suboptimal patient care. Healthcare providers usually lack the autonomy required to adjust or modify the physician's orders. Physicians are responsible for addressing all prescription items for oxygen therapy for their patients including clear SpO₂ target. However, RTs or nurses should be allowed to adjust FiO₂ or flow rate accordingly. Finally, a large variation between prescribed oxygen therapy and administered oxygen was observed, which may be due to variation between the medical charts and RC charts, and modification in oxygen therapy without proper documentation. Education sessions for health care providers focused on oxygen therapy are needed to improve the current situation.

Our study has some limitations. Data were collected from a large teaching hospital, so the results should be generalized nationally with caution. A multi-centre study including more hospitals is needed to improve generalizability of current findings. Moreover, adding some physiological variables may be useful for quantifying the impact of proper oxygen prescription and administration on the patient's clinical management. Nevertheless, the present data highlighted the need for a national large-scale audit on oxygen therapy prescription and administration. The current results could be used to improve development of policy and procedure guidelines for oxygen therapy prescription and administration, and serve as a benchmark for other healthcare institutions.

Conclusions

Current practice of oxygen therapy prescription and administration was suboptimal. Oxygen therapy prescriptions should include all items according to the hospital policy and procedure guidelines. RTs and nurses should encourage physicians to write complete prescriptions and strictly follow them. Continuous or at least more frequently oxygen therapy monitoring is highly recommended. A study investigating oxygen therapy practice on a larger scale is needed to enable improvement of patient care.

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Conflict of interest

The author have no conflict of interest to declare.

Ethical approval

The study was approved by the hospital's ethics committee. Data were anonymized by removing any personal information for the purpose of confidentiality.

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