An audit of oxygen therapy on the medical ward in 2 different hospitals in Central Saudi Arabia

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ABSTRACT

Objectives: To study the use of oxygen therapy on the medical wards in 2 hospitals in Riyadh, Kingdom of Saudi Arabia. One was academic, King Khalid University Hospital and the other a community hospital, Riyadh Medical Complex.

Methods: This study was carried out over a one year period, 6 April 2000 through to 6 April 2001. Oxygen saturation was measured randomly by pulse oximetry in patients receiving oxygen therapy. Charts of the patients were inspected for relevant information related to oxygen therapy, including indications, dose, monitoring and documentation of the order. If oxygen saturation was >97% oxygen flow was reduced to maintain oxygen saturation between 92% and 94%. The potential savings by such reduction were calculated.

Results: A total of 108 patients were studied. The most frequent indications for oxygen therapy were hypoxemia and dyspnea. Arterial oxygen tension before starting oxygen was carried out for 78 patients (72.2%) and showed that the majority (60 patients, 76.9%) were hypoxemic arterial oxygen tension ≤ 65 mm Hg). The last documented arterial oxygen tension values after initiating oxygen were found in 79 patients (73.1%) and these were carried out at mean interval of 111 hours (range one-1200) before our assessment. Most patients (32 patients, 40.5%) had excessive values (>85 mmHg), 24 patients (30.4%) were hypoxemic (arterial oxygen tension ≤65 mmHg) and only 23 patients (29.1%) had acceptable values (arterial oxygen tension > 65-85 mmHg). Our measurements also showed that arterial oxygen tension was excessive (>97%) in 59 patients (54.6%), adequate (≥92%-97%) in 44 patients (40.7%), and only a minority (5 patients, 4.6%) were hypoxemic (<92%). Oxygen dose could be reduced in 31 patients (28.7%) by a mean of 42% (range 18%-66%) and stopped in 38 patients (35%) while maintaining aterial oxygen tension between 92%-94%. Errors in oxygen prescription were more apparent in the non-academic setting (P<0.05%).

Conclusions: Oxygen prescription was sub-optimal in both the academic and non-academic setting. The study highlights the need to adopt and evaluate cost-effective measures such as oxygen titration protocols using pulse oximetry, and physician education programs.

Keywords: Oxygen therapy, pulse oximetry, hypoxemia, academic and community hospitals.

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Supplemental oxygen is used commonly for patients on the acute care medical wards. Guidelines on oxygen therapy, in terms of indications, dosage and monitoring, were established many years ago.[1-3] Yet, studies to date in different countries continue to show poor adherence to these guidelines.[4-9] Locally, we also observed inappropriate oxygen practices. However, there is no information on the magnitude of the problem or type of the common errors in these practices. The goal of this study was to study oxygen prescription in 2 hospitals in Riyadh, Kingdom of Saudi Arabia (KSA)

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comparing the academic and non-academic setting and to suggest cost-effective measures to improve the current practice.

Methods. The study was carried over a period of one year starting Moharram 1st 1421 (6th April 2000 through to 6th April 2001. Patients receiving oxygen therapy in the medical wards in King Khalid University Hospital (KKUH) and Riyadh Medical Complex (RMC) were selected randomly to undergo oxygen saturation measurement using pulse oximetry. The ethical committee of the College of Medicine Research Council approved the study. Neither physicians nor nurses were aware that this study was going on. In both hospitals respiratory therapists were not involved in oxygen prescription and pulse oximeters were not readily available on the wards.

The clinical profile of each patient was reviewed and documented in a pre-designed data sheet. The chart was checked for the indications (clinical and according to the American College of Chest Physicians and National Heart, Lung and Blood institute (ACCP/NHLBI) guidelines,[2] the presence of oxygen order and dose of prescribed oxygen, oxygen measurements, type of device used (namely nasal canula, mask), if the patient was wearing the oxygen at the time of the visit, and his or her reasons for not wearing oxygen if this happened to be the case. Oxygen saturation (SpO_2) was measured while the patients receiving supplemental oxygen (O_2) using a pulse oximeter (Nellcore NPB-40). Other factors that may interfere with the accuracy of the measurements such as Henna paste or other dyes, recent smoking, drugs, poor signal were looked for and dealt with if found by using ear probe, changing site or deferring measurement to another time. At least 10 minutes would lapse to allow reading to stabilize (≤1% variation) before recording the value. Data was analyzed using StatPac Gold statistical analysis package.

Results. A total of 108 patients were included in the study. The clinical and demographic characteristics are shown in **Table 1**. There were more Saudis, more females and more patients with cardiopulmonary disease in KKUH compared with RMC. Also, patients at KKUH had lower mean arterial oxygen tension (PaO_2) values than patients at RMC. Indications for oxygen therapy are shown in **Table 2**. The most frequent indications were dyspnea and hypoxemia, but in 17.6% of patients reasons for starting oxygen were not clear. Arterial oxygen tension before starting O_2 was measured for only 78 (72.2%) and this showed the following values: ≤65 mm Hg in 60 patients (76.9%), >65-85 mm Hg in 15 patients (19.2%) and >85 mm Hg in 3 patients (3.8%). An order for starting oxygen was

Table 1 - Demographic and clinical characteristics.

Characteristics	KKUH	RMC	P value*
Age (years)			
Mean	60.2	57.2	0.44
Standard deviation	19.2	21.1	
Nationality			
Saudi	56	29	0.0021*
%	(91.8)	(65.9)	
Sex			
Male	19	33	0.0001*
%	(30.6)	(71.7)	
Diagnosis			
Pulmonary	30	11	0.0067*
Cardiac	16	10	
Others	16	25	
Oxygen order present	54	35	0.1494
%	(88.5)	(76.1)	
Before oxygen therapy			
N of patients who had ABG	48	30	0.1687
			0.0066*
Mean PaO_2 ± SD mmHg	52.92±12.34	64.92±28.93	
After oxygen therapy			
N of patients who had ABG	51	28	<0.05*
Mean PaO_2 ± SD mmHg	75.40±27.33	112.83±42.08	<0.00001*
Our assessment (SpO_2)			
N of patients	62	46	
Mean ± SD	97.02±2.53	97.28±4.12	0.3394
Adjustment in oxygen dose			
Reduced	22 (35.5)	9 (19.6)	
Stopped	15 (24.2)	23 (50)	0.0179*
No change	25 (40.3)	14 (30.4)	
Compliance	53 (85.5)	42 (91.3)	0.5351

SD - standard deviation, KKUH - King Khalid University Hospital, RMC - Riyadh Medical Complex, PaO_2 - arterial oxygen tension, SpO_2 - oxyen saturation measured by pulse oximetry, ABG - arterial blood gases, N - number, * p value - determined by T-test, Z-test and chi-square, signifcant: <0.05%

Table 2 - Indications for starting oxygen.

Indication	KKUH Patient N 62	RMC Patient N 46	Total (%) N 108
Dyspnea	39	29	58 (53.7)
Hypoxemia	40	17	57 (52.8)
Respiratory distress	32	13	45 (41.7)
Tachypnea	15	12	27 (25)
Chest pain	4	3	7 (6.5)
Cyanosis	0	3	3 (2.8)
Miscellaneous	8	3	11 (10.2)
Unclear	5	14	19 (17.6)

KKUH - King Khalid University Hospital, RMC - Riyadh Medical Complex, N - number,
* - several patients had more than one indication for oxygen therapy

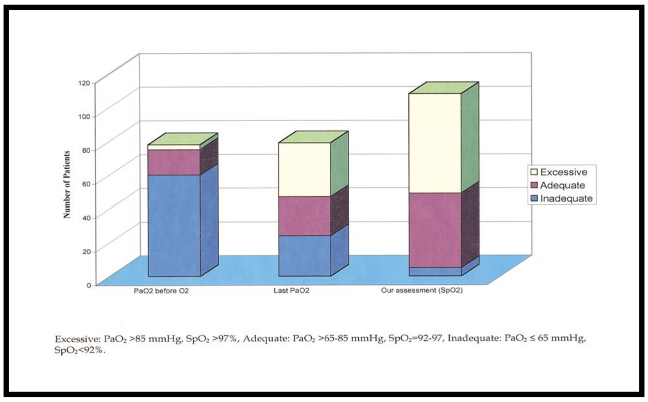

Figure 1 - Oxygen measurements before, last after oxygen therapy and our assessment PaO_2 - arterial oxygen tension, SpO_2 - oxyen saturation, O_2 - oxygen.

documented in the order sheet in 82.4% of the patients' charts. The ranks of the physician who made the order were as follows: resident: 38, registrar 37, interns 4, consultant one and in 28 cases the rank could not be identified. The oxygen apparatus was as follows: nasal canula 49, simple mask 35, Venturi mask 23, and rebreath mask in one patient. A follow up PaO_2 (the last if there was more than one measurement) after starting oxygen was carried out in 79 patients (73.1%) and values were ≤65, >65-85 and >85 mm Hg in 24 patients, 23 patients, and 32 patients (30.4 %, 29.1%, and 40.5%). These were carried out at mean interval of 111 hours (range one-1200 hours) before our assessment.

Our assessment findings were consistent with the follow up PaO_2; SpO_2 was inadequate (<92%) in 5 patients (4.6%), adequate (SaO_2 >92%-97%) in 44 patients (40.7%) and excessive (SpO_2 >97%) in 59 patients (54.6%). However, our assessment showed higher proportion of excessive values and lower proportion of inadequate values. A graphic summary of the above results is shown in **Figure 1**.

We were able to reduce oxygen dose to a mean of 42% (range 18%-66%) in 31 patients (28.7%) and stop it completely in 38 patients (35%) while maintaining SpO_2 between 92%-94%. Details of this in each of the 2 hospitals are shown in **Table 1**. The difference between the hospitals was statistically significant (P=0.0128), suggesting more overuse of oxygen at RMC. This was consistent with calculations (see below) of the amount of oxygen that can be saved at each of the 2 hospitals (63% at RMC and 40% at KKUH).

Cost calculation. At RMC, the amount of oxygen that can be saved by reducing or stopping this gas was 63.6%. The yearly cost of oxygen gas for the medical wards is 80,300 Saudi riyals (SR). This means saving of 51071 SR yearly. Consumption of the medical wards is only 10% of oxygen supply of the hospital. If we assume a similar pattern of dealing with oxygen in other hospital sections the potential savings can then exceed half a million SR.

At KKUH the reduction of oxygen usage was 40%. The cost of oxygen for the whole hospital was 199,750 SR for the year of the study. The consumption of the medical wards could not be estimated, as the hospital uses a central supply of liquid oxygen to all the wards through tubing in the walls. If a similar pattern of oxygen prescription is assumed, savings can be up to 79,900 SR per year.

Compliance to oxygen therapy amongst patients. Ninety-five patients (88%) were wearing oxygen apparatus when evaluated. Different reasons were given by the remaining 12 patients for not wearing oxygen apparatus (such as talking in patients wearing masks, the flow was not felt or obnoxious, feeling of heat, taking oxygen as needed, and one patient was not convinced of the benefit).

Discussion. In this study the oxygen prescription process was assessed in relation to the published guidelines.[1-3] The first question that arises is whether oxygen therapy is indicated. On reviewing records of our patients a significant proportion (17.6%) the indications for oxygen therapy were not clear. It is worth noting that the guidelines give physicians a leeway in justifying oxygen prescription.[1-4] Also, we did not inquire regarding the indications directly from the prescribing physician, as awareness of this study might change the physicians' behavior (the Hawthorne effect). Hypoxemia, the physiological indication for supplemental oxygen, accounted for 52.8% which is higher than other studies (30%-42%).[4,7,8] Possible explanations for this include differences in patients' characteristics (such as severity of illness), setting (medical versus surgical wards) or physicians' practice (vigor in searching for hypoxemia). Our physicians did not seek documentation of hypoxemia in all patients. Arterial blood gases was carried out for 72.2% of the patients, which is in the range of previous studies (50%-82%).[6-9] Reassessment of oxygenation after initiating oxygen was carried out for a similar proportion (73.1%) and after considerable delay in some patients. Physicians might have overlooked the need for oxygen therapy in some patients. However, we have shown, in another study, that hypoxemia was overlooked rarely (1.5%) in patients hospitalized on the medical wards.[10]

Our results are consistent with previous studies in showing that physicians do not seriously view oxygen as a drug that needs careful considerations for indications, dosage and monitoring. Small et al[6] compared the prescription of oxygen to that of antibiotics and found that 87% of physicians ordered cultures before starting antibiotics, whereas oxygen level was measured in only 61% of the patients. Also, the oxygen order was not documented in the order sheet in 17.7% (which is almost the same as our finding), while there was no single case of an antibiotic given without an order.[6]

Both of our reassessment PaO_2 ordered by physicians and our measurements of SpO_2 showed that patients were more likely to be over-oxygenated than under-oxygenated, and only 30%-40% of patients had values within the acceptable range. The difference between these 2 assessments (Higher proportion of excessive values and lower proportion of inadequate values in our assessment) probably reflects improvement in the patients' condition with time. This highlights the need for periodic monitoring of oxygen level, which was shown to be a significant factor in the decision to discontinue oxygen therapy.[7] During our assessment we were able to reduce oxygen dose in 28.7% and stop it completely in 35% of the patients, while maintaining $SpO_2 \geq 92\%$. Only 5 patients (4.6%) were found to be hypoxemic. Such adjustments in oxygen dosage, aside from minimizing the risks of oxygen toxicity[11] in many patients can also result in significant cost reduction. In our study we did not quantify the additional costs related to inappropriate prolongation of oxygen therapy. Therefore, the potential savings can be greater. In a similar study, Albin et al[5] found in a study of 507 assessments of oxygen saturation that in the majority of hospitalized non-ICU patients, oxygen prescription was not required (46%) or excessive (38.1%), and in 16% of the determinations it was insufficient. They also found that considerable savings could be made by judicious use of oxygen (over United States Dollars 100,000 in their centre). Similar findings, including a significant cost reduction, were also reported by Brougher et al.[4]

Such potential savings can be utilized to support interventional programs that include monitoring SpO_2 and education of physicians and nurses. Measurement of SpO_2 was suggested as a 5th vital sign.[12] Indeed, oximeters are now included with devices measuring other vital signs at little extra cost. This may lead to an improvement in oxygen prescription, although controlled studies are lacking. One recent study showed that oxygen prescription was poor despite such measures.[9] However, this study did not have baseline values or a control group to demonstrate the lack of improvement in the practice. In other studies, the use of oxygen tapering protocols was found to be effective in improving oxygen prescription.[13,14] Other protocols involving respiratory therapists showed similar success,[15,16] but it is doubtful if these will receive support due to the extra costs and work pressure on the respiratory therapists. Albin et al[5] managed to solve this problem by employing "oximetry technicians" with lower salaries.

Finally, patients' compliance is another issue in oxygen therapy. Only 12% of our patients were not wearing oxygen apparatus when we performed our assessment. In a study in United Kingdom,17.6% of patients were not wearing the apparatus correctly or not at all,[8] while an even higher rate (47%) was observed in a study on American patients.[5] It is possible that regular estimation of SpO_2 might improve patients' compliance, although we are not aware of studies on this issue.

The study was carried out in 2 hospitals so that comparisons can be made between the academic and the general community hospital settings. This should enhance the generalizibilty of our conclusions, as it may be argued that results from an academic institution cannot be extrapolated to the more frequent general hospital setting. Indeed, a significant difference was noticed between the 2 hospitals in terms of dosing and monitoring oxygen, but even in the academic setting, the practice was sub-optimal.

In conclusion, this study demonstrated a number of deficiencies throughout the oxygen prescription process for medical patients hospitalized outside the intensive care unit, which were more apparent in the non-academic setting. Education of physicians, the use of oxygen tapering protocols and other cost-effective measures need evaluation and repeat audits should be performed as a part of the continuous quality improvement process.

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