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Oxygen therapy assessment in adult patients at an intensive care unit of a teaching hospital

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Abstract

Objective: to carry out a situational diagnosis of the adequacy of oxygen therapy prescriptions in an adult intensive care unit (ICU) of a teaching hospital in Northeast Brazil. **Methods:** this is a cross-sectional, descriptive, retrospective, and quantitative study, in which the medical records and prescriptions of patients using oxygen, admitted to the ICU between March and June 2021, were evaluated, based on the guidelines of the British Thoracic Society (BTS). This advocates that target O_2 saturation, delivery device and initial O_2 flow are minimum and mandatory criteria for prescribing oxygen therapy. The project is part of a larger research approved by the ethics committee in research involving human beings with the number 3,709,534 (CAAE n° 22984119.9.0000.5546). **Results:** The sample consisted of 42 patients. Of these, 90.5% had an indication for the use of oxygen, but only 71.4% had oxygen therapy in the prescription. No prescription contained the target saturation, 64.3% had the delivery device, and 16.7% contained the initial flow or inspired fraction of O_2. **Conclusion:** The study demonstrated that oxygen prescriptions in the researched care unit do not meet the BTS recommendations and that interventions should be performed to make care safer.

Keywords: hospital; oxygen therapy; inappropriate prescription.

Avaliação da oxigenoterapia em pacientes adultos em uma unidade de terapia intensiva de um hospital de ensino

Resumo

Objetivo: realizar um diagnóstico situacional da adequação das prescrições de oxigenoterapia em unidade de terapia intensiva (UTI) de adultos de um hospital de ensino do Nordeste do Brasil. **Métodos:** trata-se de um estudo de caráter transversal, descritivo, retrospectivo e quantitativo, no qual foram avaliados os prontuários e prescrições dos pacientes em uso de oxigênio, internados na UTI entre os meses março e junho de 2021, com base nas diretrizes da *British Thoracic Society* (BTS). Esta preconiza que saturação alvo de O_2, dispositivo de entrega e o fluxo de O_2inicial são critérios mínimos e obrigatórios a prescrição de oxigenoterapia. O projeto faz parte de uma pesquisa maior com aprovação no comitê de ética em pesquisa envolvendo seres humanos com o número 3.709.534 (CAAE n° 22984119.9.0000.5546). **Resultados:** A amostra foi composta por 42 pacientes. Destes, 90,5% possuía indicação de uso de oxigênio, porém apenas 71,4% constava a oxigenoterapia na prescrição. Nenhuma prescrição continha a saturação alvo, 64,3% apresentava o dispositivo de entrega e 16,7% continha o fluxo inicial ou a fração inspirada de O_2. **Conclusão:** O estudo demonstrou que as prescrições de oxigênio na unidade assistencial pesquisadas não atendem às recomendações da BTS e que intervenções devem ser realizadas para tornar o cuidado mais seguro.

Palavras-chave: hospital; oxigenoterapia; prescrição inadequada.

Introduction

Medical gases are used alone or in combinations with the objective of performing pharmacological activities, either by inhalation therapy or by *in vivo* diagnosis. They are regulated as a medication all over the world and France was the pioneer country in this regulation, in 1992[1,2]. However, it was only in 2008 that the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*, ANVISA) implemented such regulation in Brazil[3,4]. Among medical gases, oxygen is the most employed in medicine and its use is called "oxygen therapy". Its application is indicated for patients with some respiratory dysfunction

associated with an underlying disease or metabolic imbalance due to pathological complications such as chronic obstructive pulmonary diseases, pulmonary fibrosis or other conditions such as COVID-19. It acts by supporting cell function and metabolism, reducing the chances of organ dysfunction, and is widely used in cardiovascular resuscitation[5,6].

However, abusive oxygen use in patients can cause serious consequences such as induced hypoventilation, with a greater potential risk in individuals without respiratory failure. This inadequacy increases the possibility of hyperoxia and production of reactive oxygen species that cause tissue damage and stimulate inflammatory processes in the lungs. In addition to that, excessive oxygen use in patients with severe Chronic Obstructive Pulmonary Disease (COPD) can cause a decrease in hypoxic stimulation involved in the respiratory drive with consequent hypoventilation and additional carbon dioxide retention, with possible interruption of ventilation[6,7]. To ensure rational oxygen use, the work of professionals from different areas in patient care is necessary, with pharmacists as indispensable agents for the use of this medication, as expressed in Resolution 731/2022 of the Federal Pharmacy Council[7,8].

The British Thoracic Society (BTS) created a guideline for safe oxygen therapy, based on clinical criteria aimed at preventing the adverse effects of using excess oxygen. The measures to be taken include the criteria that must be present in a medical prescription, such as target saturation, delivery device and initial O_2 flow (L/min). It is important to emphasize that the ideal saturation for people at risk of hypercapnic respiratory failure should be between 88% and 92% and, for people without these conditions, between 94% and 98%[9,10]. Among the six international goals of patient safety, the World Health Organization and ANVISA highlight the goal of safety in drug prescription, use and administration, where they draw the attention to the importance of a complete medical prescription to guarantee proper medication use[11].

Faced with studies carried out in several countries, which presented inadequacies in the oxygen therapy prescriptions, as well as the high cost of medications for health institutions and the international patient safety goals, this research aimed at carrying out a situational diagnosis of the profile corresponding to the prescription of medical oxygen in an ICU of a teaching hospital, through the evaluation of prescriptions and medical records of hospitalized patients, identifying compliance with good practices for prescribing medical oxygen, based on criteria determined by the British Thoracic Society (BTS).

Methods

This is a cross-sectional, descriptive and retrospective study with a quantitative approach, in which prescriptions and medical records of patients admitted to the General ICU and COVID-ICU of the Sergipe University Hospital and subjected to oxygen therapy were evaluated. The evaluation was guided by the criteria of the oxygen therapy guide prepared by the British Thoracic Society (BTS), as well as by national protocols issued by the Brazilian Association of Intensive Care Medicine and the Ministry of Health regarding the O_2 use in critically-ill patients with COVID-19, in addition to the ANVISA safety manual for drug prescription, use and administration.

For sample size calculation, an electronic tool was used for this purpose with the Confidence Interval of a Proportion, available at http://calculoamostral.bauru.usp.br/calculoamostral/ta_ic_proporcao.php. Based on the results of the study by Gunathilake *et al.* (2014), who investigated the prevalence of oxygen therapy prescriptions, and considering the population of patients using oxygen therapy at the Sergipe University Hospital in the period evaluated, the sample size calculation considered an α Error = 0.05 and a 95% confidence level, resulting in 42 patients.

A day of the month was randomly defined for the evaluation of medical records and prescriptions. Initially, all medical records of patients who were hospitalized in both Units on the 20th of March, April, May and June 2021 were checked. The medical records of patients using oxygen were segregated for the evaluation of prescriptions and medical, nursing and physiotherapy evolutions.

To assess whether the patients had an indication for oxygen therapy use, the medical, physiotherapy and nursing evolutions were evaluated, seeking the saturation under which each patient was before receiving oxygen. The research considered the following as candidates for oxygen supplementation based on the BTS criteria: patients with SatO2 <94% or <88% (in cases of patients at risk of increased CO_2 partial pressure or hypercapnia) and in their absence, records in the medical chart of any diagnosis that justifies oxygen supplementation, in addition to patients who have already been admitted intubated or receiving oxygen through other devices. The presence of oxygen in the prescription was checked and whether it included target saturation, delivery device and initial oxygen flow (L/min) or inspired fraction (FiO_2).

Considering the frequent use of invasive mechanical ventilation within the ICU, it was included in the survey as a "delivery device". Patients using mechanical ventilation with an FiO_2 value of 21% were excluded, as this was not oxygen therapy. In addition to that, the patients using oxygen through any delivery device, but without a prescription for this gas, were considered in the analysis of this study.

The form used in data collection assigned dichotomous "Yes" or "No" answers to each item (Figure 2). The data were tabulated in a Microsoft Excel® 2013 spreadsheet and analyzed using descriptive statistics. If a patient was not using oxygen on the 20th of any month but did use it at some point during the period, a retrospective search would be carried out in their medical records, up to the closest day on which they were using oxygen therapy. In cases of patients who remained in the same hospitalization unit in subsequent months, new samples were not considered.

The study is part of the project entitled "Medical gases: Instrument validation, hospital use profile and identification of problems related to these drugs" approved by the Committee of Ethics in Research involving human beings under number 3,709,534 (CAAE No. 22984119.9. 0000.5546).

Results

In order to reach the number of patients to be evaluated, defined by the sample calculation, 58 medical records were evaluated (Figure 2). Among the medical records studied, 90.5% (n=38) had diagnoses that proved the need for oxygen use, although the vast majority of medical charts did not record the initial saturation, measured before using oxygen therapy. As for the

Figure 1. Instrument for data collection from the oxygen therapy prescriptions and medical records.

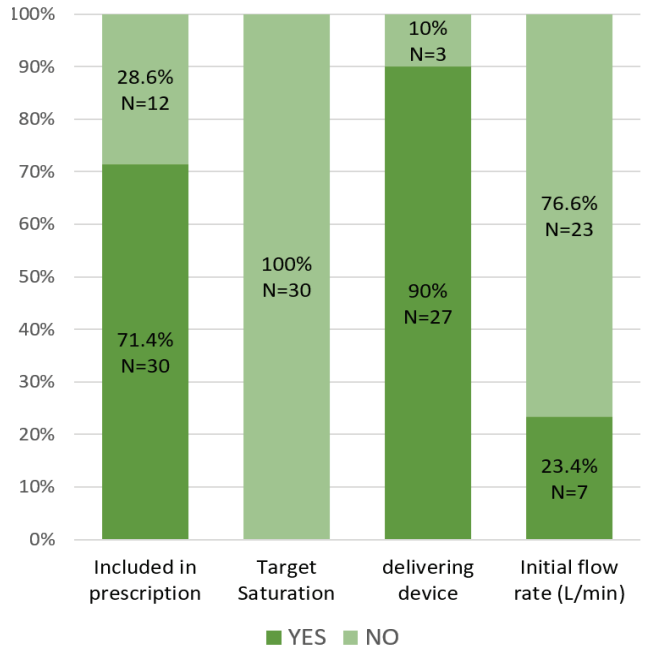
Date: / /	**Patient/Sector**									
Oxygen therapy indication	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Included in the prescription	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Target oxygen saturation	1/2/3	1/2/3	1/2/3	1/2/3	1/2/3	1/2/3	1/2/3	1/2/3	1/2/3	1/2/3
O_2 saturation measuring method	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2	SpO_2/ SaO_2
Oxygen delivery device	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g	a/b/c/d/ e/f/g
Initial flow (L/min) or FIO_2	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N

Key: Y/N (Yes/No); 1: 88%-92%; 2: 94%-98%; 3: Not recorded. SpO_2: Peripheral oxygen saturation; SaO_2: Arterial oxygen saturation; a: Nasal catheter; b: Hudson mask; c: Venturi mask; d: Non-rebreathing mask; e: Orotracheal intubation; f: Tracheostomy; g: Non-invasive ventilation. Adapted from Gunathilake et al., 2014.

record in the medical prescription, 71.4% (n=30) had this therapy duly prescribed. In addition, 9.5% (n=4) of the patients admitted to the ICU were using oxygen, but with insufficient information in the medical records to prove the real need. Therefore, 12 patients were using oxygen therapy without proper medical prescriptions.

Of the minimum information that must be included in an oxygen therapy prescription established by the BTS, the target O_2 saturation ($SatO_2$), which can be considered the most important, was the item that presented the worst result, as none of the prescriptions analyzed contained this data. As for the oxygen delivery device, the data pointed out that 90% (n=27) of the prescriptions contained this information, with most patients, which represents 88% (n=24), using mechanical ventilation with tracheostomy (TCT) or orotracheal tube (OTT). The others had a nasal catheter (NC).

Figure 2. Items evaluated in the oxygen therapy prescriptions (Aracaju, Brazil, 2023)



L/min = Liters per minute. FiO_2 = Inspired Oxygen Fraction

With 23.3% (n=7), the second most absent piece of information was the initial O_2 flow or the initial O_2 inspired fraction. However, it is important to note that 18 patients who had oxygen prescribed presented the oxygen fraction of inspired (FIO_2) in the medical or physiotherapy evolutions. Finally, the study identified the methods used to measure O_2 saturation, with 40.5% (n=17) measured using pulse oximetry and 59.5% (n=25) by means of blood gas analysis.

Discussion

Oxygen therapy directly contributes to improving the quality of life and survival of patients with chronic hypoxemic diseases, according to randomized studies carried out by North American entities that correlated the mean daily duration of oxygen therapy with patient survival[12]. Oxygen has benefits for patients affected by various diseases; however, it should be used with caution due to its deleterious effects. The results pointed out that most of the patients required oxygen therapy use, as well as that the majority were prescribed oxygen, and that no prescription had all the necessary information according to the BTS guidelines. This completeness in the prescription is indispensable for an adequate pharmacotherapy, be it with a medical gas or with medications in any other pharmaceutical form.

Between 1997 and 1998, a research study analyzed the effect of lectures and the creation of an oxygen prescription table for physicians in a hospital from the United Kingdom. The research involved 115 individuals who were in hospitals and analyzed the oxygen therapy treatment offered for 3 months. Of all 63 patients, 55% were receiving oxygen, but only 8% of them had an accurate prescription[13]. After this diagnosis, interventions were performed and the study was repeated, presenting 91% of the patients with properly prescribed oxygen and 77% of correct prescriptions. The current study, carried out 25 years later, showed that we still have a long way to go in caring for patients who need oxygen, and that the involvement of a properly trained multiprofessional team, including pharmacists, may contribute to changing this reality.

Another study, conducted with the same premise at a rural hospital in Australia, evaluated 682 patients during 10 days, of which 82 were using oxygen therapy; the results showed that only 2.4% (n=2) of the prescriptions were in line with the BTS criteria. After

creating a guidance table, 34% (n=24) of the patients had correct oxygen prescriptions, which showed that the table reduced the number of inappropriate prescriptions, increasing patient safety indicators at the institution[15]. These studies reveal that misuse of the gas has been examined in other countries for over 20 years, unlike in Brazil, which has scarce literature on the subject matter. This fact may be contributing to the scenario identified in the current research.

A study carried out in New Zealand, analyzing oxygen therapy in an ICU, showed the benefits of using a table with criteria for indicating, monitoring and administering oxygen throughout the hospital. The research revealed that only 20% of the patients in the ICU on oxygen therapy had the gas prescribed, and that 6% of them had precise prescriptions[16]. This research reinforces the findings of previous studies, as it involves a problem of identifying the need for oxygen use prescription and documentation. In the same study, 9.5% (n=4) of the samples were using oxygen without correct indications; in addition to that, most of the patients did not have the initial saturation described in the medical records, allowing a deficiency in the analysis of the oxygen therapy indication since, without this data, it was not possible to assess whether any patient used the gas with normal saturation. The same happened in the current study, as the saturation prior to oxygen therapy initiation was not properly recorded in most of the medical records evaluated.

A study carried out in London assessed oxygen use in more than 16,000 adults with acute pulmonary diseases, comparing mortality and morbidity data in the use of liberal or conservative oxygen therapy. The research was based on the dose-dependent effect and indicated that abusive oxygen use is harmful to the body, as there was an increase in mortality in the short- and long-term among the patients who received higher doses. In addition to causing vasoconstriction, inflammation and oxidative stress in the patients' lungs, liberal use interferes with hospitalization times. Small changes in oxygen saturation can be harmful to the patients, as they increase the partial oxygen pressure (PaO_2). Therefore, using a saturation range is ideal to minimize such risks, which would be from 94% to 96% according to the study[16,10]. This saturation range is also recommended by the Australia and New Zealand Thoracic Societies[17]. This shows the relevance of including this information in medical prescriptions for oxygen therapy and that its proper use has the potential to contribute to improving care and economic indicators at the health institution.

In the current study, the most common criterion in ICU prescriptions was delivery device, followed by initial flow. Using inadequate flows can be harmful because, in addition to not correcting saturation, it can suffocate the patient[18]. A previous study, conducted in the same hospital but in the Medical Clinic sectors, revealed that the most recurrent delivery device was the nasal cannula, found in 85.7% of the patients evaluated[19]. Within the ICU, mechanical ventilation was the most recurrent device in the prescriptions due to the criticality of the patients assisted in the sector. Mechanical ventilation is indicated for complications due to intrinsic lung disease and hypoxemia, cardiorespiratory arrest, respiratory system failure, muscle weakness and postoperative recovery[20].

Regarding the monitoring of patients on oxygen therapy in the ICU, the methods used were blood gas analysis and pulse oximetry, with the former being the most frequent in the records. The literature does not specify how many daily measurements are necessary, but recommends that blood gas collections be performed in all patients using oxygen support, as well as in those with respiratory decompensation[21]. This method is very effective for monitoring or indicating O_2 use since, with the gasometer, it is possible to analyze the PaO_2, partial carbon dioxide pressure (pCO_2), hydrogen potential (pH), bicarbonate (HCO_3) and $SatO_2$ parameters, The literature shows that 91% of the patients with respiratory failure in the ICU required invasive ventilation and that gasometry is crucial to assist in defining the parameters to be programmed in the mechanical ventilator, thus representing the most frequently employed method in ICUs[22,23].

A number of studies in the field question why health teams do not use oxygen as recommended in the guidelines[24,25]. An analysis carried out in a Chilean hospital concluded that this problem is linked to lack of information in multidisciplinary teams about administration and adverse effects of the gas, in addition to the absence of guidelines on oxygen therapy in hospitals and other health sectors[24]. The study carried out in Saudi Arabia revealed that the professionals have little knowledge about how to use the medical gas, directly interfering in their actions, which can harm patients in critical situations. The main factors that led to the teams' lack of knowledge were absence of national oxygen therapy guidelines, lack of lectures and other training options in the area and, finally, high workload[25]. Given the diverse information presented and the results of this study, it is possible to deduce the need to define an institutional protocol, training the multiprofessional team and defining a prescription model.

Despite being considered a topic rarely discussed with and by pharmacists in Brazil, the study evaluating the quality of oxygen prescriptions has the potential to contribute to raising awareness about the importance of this theme in Brazil, such as including it in undergraduate Pharmacy courses and contributing to patient safety. This study was conducted at a single institution. In addition to that, it presents the fact that patients with COVID-19 arrived at the ICU transferred from other health institutions already using oxygen as another limitation, with impossibility to collect the saturation value before oxygen therapy initiation but, based on the diagnosis, they were considered as with oxygen indication.

Conclusion

This study showed that the oxygen therapy prescriptions in the ICU researched do not include all the information recommended by the BTS. However, the vast majority of the patients had an indication for its use.

Given the above, it is possible to identify opportunities for improvements in the prescription process and in the use of medical oxygen in the ICU under study. This reality is reproduced in several studies carried out at hospitals in European, Oceanian and American countries, showing that if appropriate measures are adopted, it is possible to promote safer and more effective care and to optimize resources used in health care worldwide.

New studies are required to analyze the situation of Brazilian hospitals, with the objective of diagnosing, proposing interventions and monitoring their impact.

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Collaborators

MLB, BLS and FJRA participated in design of the project, research in the medical records, and writing and review of the final text. GCC, FJNL, DTO and APLV contributed to the methodological analysis, literature review and review of the final text.

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Declaration of conflict of interests

The authors declare that there is no conflict of interest.

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