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Evaluation of oxygen therapy in adult patients in teaching hospital of Sergipe

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Abstract

Objective: To evaluate oxygen therapy prescriptions for patients under clinical care admitted to a teaching hospital in Sergipe. **Methods:** This is a cross-sectional, descriptive, retrospective and quantitative study, in which the medical records and prescriptions of 28 patients using oxygen (O2) hospitalized between March and June 2021 were evaluated. to the indication of O2 and initial oxygen saturation (SatO2), and the prescriptions regarding the inclusion of O2 in the prescription, target saturation, O2 delivery device and initial flow or initial inspired O2 concentration. After data collection, a panel of experts was formed, composed of a pulmonologist, physical therapists and pharmacists to evaluate the findings and suggest interventions to be carried out. **Results:** Of the patients evaluated, 89.3% had an indication for oxygen therapy, but 72.4% of the medical records did not present information on initial SatO2. Of the sample analyzed, 53.6% did not have prescribed O2, 75.0% did not have a SatO2 target, 42.9% did not have an O2 delivery device, and 67.9% did not have the initial flow or inspired concentration of oxygen. initial O2. In addition, the nasal catheter was the most prescribed device (85.2%). The panel of experts suggested nine interventions to be carried out, which ranged from training professionals involved in the entire process of using medical oxygen, to modifying the current medical prescription model to meet the necessary requirements for a prescription of adequate oxygen, in order to promote the practice of rational use of oxygen and adjustments in the work process. **Conclusion:** The study showed that most of the items evaluated in the oxygen prescriptions presented non-compliance with international recommendations. These findings justify carrying out interventions with the care team.

Keywords: oxygen inhalation therapy, patient safety, inappropriate prescribing, hospitals.

Avaliação da oxigenoterapia em pacientes adultos em um hospital de ensino de Sergipe

Resumo

Objetivo: Realizar a avaliação de prescrições de oxigenoterapia de pacientes sob cuidados clínicos internados em um hospital de ensino de Sergipe. **Métodos:** Trata-se de um estudo transversal, descritivo, retrospectivo e quantitativo, no qual foram avaliados os prontuários e prescrições de 28 pacientes em uso de oxigênio (O_2) internados entre os meses de março a junho de 2021. Os pacientes foram avaliados quanto à indicação de O_2 e saturação de oxigênio ($SatO_2$) inicial, e as prescrições quanto à inclusão do O_2 na prescrição, saturação alvo, dispositivo de entrega do O_2 e fluxo inicial ou concentração de O_2 inicial inspirada. Após a coleta dos dados foi formado um painel de especialistas composto por pneumologista, fisioterapeutas e farmacêuticas para avaliar os achados e sugerirem intervenções a serem realizadas. **Resultados:** Dos pacientes avaliados, 89,3% tinham indicação de oxigenoterapia, mas 72,4% dos prontuários não apresentavam informação sobre $SatO_2$ inicial. Da amostra analisada, 53,6% não tinham O_2 prescrito, 75,0% não apresentavam meta de $SatO_2$, 42,9% não apresentavam o dispositivo de entrega de O_2, e 67,9% não continham o fluxo inicial ou concentração inspirada de O_2 inicial. Além disso, o cateter nasal foi o dispositivo mais prescrito (85,2%). O painel de especialistas sugeriu nove intervenções para serem realizadas, que envolveram desde a realização de treinamentos com os profissionais envolvidos em todo o processo de uso do oxigênio medicinal, até a modificação do modelo de prescrição médica atual para atender aos requisitos necessários para uma prescrição de oxigênio adequada, com o intuito de promover a prática do uso racional de oxigênio e adequações no processo de trabalho. **Conclusão:** O estudo demonstrou que a maioria dos itens avaliados nas prescrições de oxigênio apresentavam não-conformidades diante das recomendações internacionais. Estes achados justificam a realização de intervenções junto à equipe assistencial.

Palavras-chave: oxigenoterapia, segurança do paciente, prescrição inadequada, hospitais.

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Introduction

Oxygen is the medicinal gas most frequently used in health care. It has applications in various health areas and well-established clinical indications. In the hospital context, it is mainly used in intensive care and anesthetic procedures, in ventilatory support of patients with respiratory failure of various clinical origins, in cardiopulmonary resuscitation of patients, in hyperbaric therapy, and as a vehicle in the administration of medications by nebulization or inhalation[1]. On the other hand, oxygen therapy is not indicated for patients with dyspnea without hypoxia, due to the risk of developing hypercapnia, this risk being higher in patients with chronic obstructive pulmonary disease (COPD) or type 2 respiratory failure[2,3]. In addition to that, when administered in excess, oxygen can cause lung parenchyma injury, worsening of ventilation-perfusion incompatibility, adverse cardiovascular events, reduced elimination of carbon dioxide, and intensification of pre-existing hypercapnia[3,4].

Defined by the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*, ANVISA) as a medication since 2008, oxygen, like any other medication, must be safe in its prescription, use and administration, and should be used rationally. Guidelines developed by the British Thoracic Society (BTS) in 2017 for the use of oxygen in adults at health and emergency services determine that the gas should be prescribed based on a target saturation range, and that patients undergoing oxygen therapy should be monitored and oxygen titrated depending on this range. In addition to that, it defines that the prescription should include at least the initial flow rate, the administration device, and the target oxygen saturation[5,4,6]. For most patients, a target saturation of 94% to 98% is sufficient; however, in cases where there is a risk of hypercapnic respiratory failure, target oxygen saturation should be from 88% to 92%[6].

Nevertheless, what is observed is that oxygen is often administered without a prescription, which can result in unnecessary use, even with the possibility of being used in subdose or overdose[2]. A number of research studies conducted in hospitals in several countries have shown that the practice of prescribing oxygen therapy does not follow recommendations such as those by the BTS, showing that, although there are specific guidelines on the proper use of medicinal oxygen, there are still problems in the practice of oxygen therapy[2-4,8,12,14]. However, no study of this nature was identified conducted in Brazil.

Therefore, according to our knowledge, this paper is pioneering in Brazil and had as its objective to perform a situational diagnosis of the medicinal oxygen prescription profile in a hospital through the evaluation of prescriptions and medical records of patients admitted to the wards, identifying compliance with the good practices in oxygen therapy prescription, based on criteria determined by international protocols. In addition to that, the paper aimed at identifying opportunities to improve the prescription of oxygen therapy and propose interventions with the multiprofessional team involved in the oxygen use process.

Methods

This is a cross-sectional, descriptive and retrospective study with a quantitative approach, in which the medical records and prescriptions of patients undergoing oxygen therapy and hospitalized in the general clinic, pneumology and COVID sectors of the Federal University of Sergipe University Hospital (*Hospital Universitário-Universidade Federal de Sergipe*, HU-UFS) were evaluated, for being the wards with the highest number of patients using oxygen. HU-UFS is a general teaching hospital that currently offers 142 beds and comprehensive services through the Unified Health System (*Sistema Único de Saúde*, SUS) in the municipality of Aracaju- Sergipe.

The prescriptions were evaluated regarding compliance with the criteria recommended by the British Thoracic Society (BTS) oxygen therapy guidelines regarding information on initial flow rate, administration device and target oxygen saturation. The concepts of the ANVISA 2013 protocol for safety in prescription, use and administration of medications, which recommends that prescription of a medication should be as complete as possible, were also considered[16].

For calculation of the sample size, a specific electronic tool was used for the Confidence Interval of a Proportion, available in http://calculoamostral.bauru.usp.br/calculoamostral/ta_ic_proporcao.php, using the following formula: Based on the results of the study by Gunathilake *et al.*[2], which investigated the prevalence of oxygen therapy prescriptions, and considering the population of patients undergoing oxygen therapy at the University Hospital of Sergipe in the period evaluated, the sample size calculation considered an α error = 0.05 and a 95% confidence level.

To comprise the sample, all medical records of patients hospitalized on the 20th of March, April, May and June 2021 were selected, with analysis of the medical prescriptions of those using oxygen. If a patient was not using oxygen on the 20th, but did so at some point during the period, a search was conducted in his/her medical record, retrospectively, until the next closest day when he/she was on oxygen therapy. The patients that remained in the same hospitalization unit in subsequent months were only included once in the sample.

After identifying the patients undergoing oxygen therapy, it was evaluated if they had any indication for oxygen use. For this, the medical, physiotherapy or nursing records were consulted to identify initial $SatO_2$ before initiating oxygen therapy, considering as candidates for supplemental oxygen those patients with $SatO_2$ < 94% or < 88% (in cases of patients at risk of hypercapnia). In addition to that, patients already admitted to the institution on mechanical ventilation were also included in the oxygen indication criterion, as well as those transferred from the Intensive Care Unit for patients with COVID-19 to the wards and who continued to use oxygen. Subsequently, it was verified if the patients had been prescribed oxygen. In the cases where oxygen had been prescribed, the prescription was evaluated regarding inclusion of the following information: target oxygen saturation to be achieved, oxygen delivery device, and initial oxygen flow rate or initial inspired oxygen concentration.

The items were evaluated based on dichotomous “Yes” or “No” answers. In addition to that, the patients in use of oxygen but with no prescription for this gas were also considered in the analysis performed in this study. The data were tabulated in a Microsoft Excel® 2013 spreadsheet and analyzed by means of descriptive statistics.

In order to propose interventions to be carried out at the institution, a number of professionals were selected to assemble a panel of experts, consisting of a pulmonologist, two physical therapists, a clinical pharmacist and a pharmacist in the area of hospital epidemiology and patient safety. The criterion to include

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these specialists was to cover professionals involved in the entire oxygen therapy process. The panel met only once, remotely, and the meeting lasted nearly 1 hour and 30 minutes. Based on the results found, all the professionals independently listed their intervention proposals and, subsequently, each one presented their ideas. The other specialists were allowed to make their own contributions, arguing for agreement or disagreement, and discussion of each proposal was only concluded after reaching consensus. The meeting was moderated by a professional pharmacist, who mediated the discussion without intervening.

This paper is an integral part of the project entitled "Medicinal Gases: Instrument validation, hospital use profile and identification of problems related to these medications", which was submitted to and approved by the Committee of Ethics in Research Involving Human Beings under opinion No. 3,709,534 (CAAE No. 22984119.9.0000.5546).

Results

The study sample consisted of 28 patients. To such end, the medical records of 97 patients were evaluated until reaching the required number of subjects in use of oxygen during the period under study.

Regarding the total number of patients, only 7.1% (n = 2) had oxygen prescriptions containing all the necessary information, i.e., inclusion of oxygen in the prescription, target saturation goal, delivery device and initial O_2 flow rate defined. Regarding the indication of oxygen use according to previously defined criteria, only the medical records of three patients (10.7%) did not present any justification for the use of supplemental oxygen. In addition to that, for most of the patients (20; 71.4%) it was not possible to locate any information about oxygen saturation before initiation of oxygen therapy in their medical records.

Regarding the criteria to evaluate the prescriptions according to the BTS recommendations, 53.6% of the patients had not been prescribed oxygen (Figure 1). In addition to that, only 25.0% of the patients presented the target O_2 saturation defined in the prescriptions. In their prescriptions, most of the patients (57.1%) had the device to be used in oxygen administration as per the BTS guidelines. Finally, only 32.1% of the prescriptions evaluated contained the initial O_2 flow rate value or the initial inspired O_2 concentration, which were generally described only in the evolutions.

The main delivery devices prescribed for the patients in this study were also evaluated (Figure 2), the most frequently prescribed being spectacle-type nasal catheter.

Regarding the proposals of interventions suggested after the contributions made by the panel of experts, a total of 9 interventions were discussed and listed (Table 1) to be carried out later on with the care teams in order to promote the practice of rational oxygen use. The interventions ranged from training with the professionals involved in the entire process of using medicinal oxygen, including physicians, nurses, physiotherapists and pharmacists, to modification of the current medical prescription model to meet the requirements for an oxygen prescription considered correct, including the implementation of target saturation signposts for each patient using this medication and the review of the oxygen therapy institutional protocol.

Figure 1. Items evaluated in the oxygen therapy prescriptions

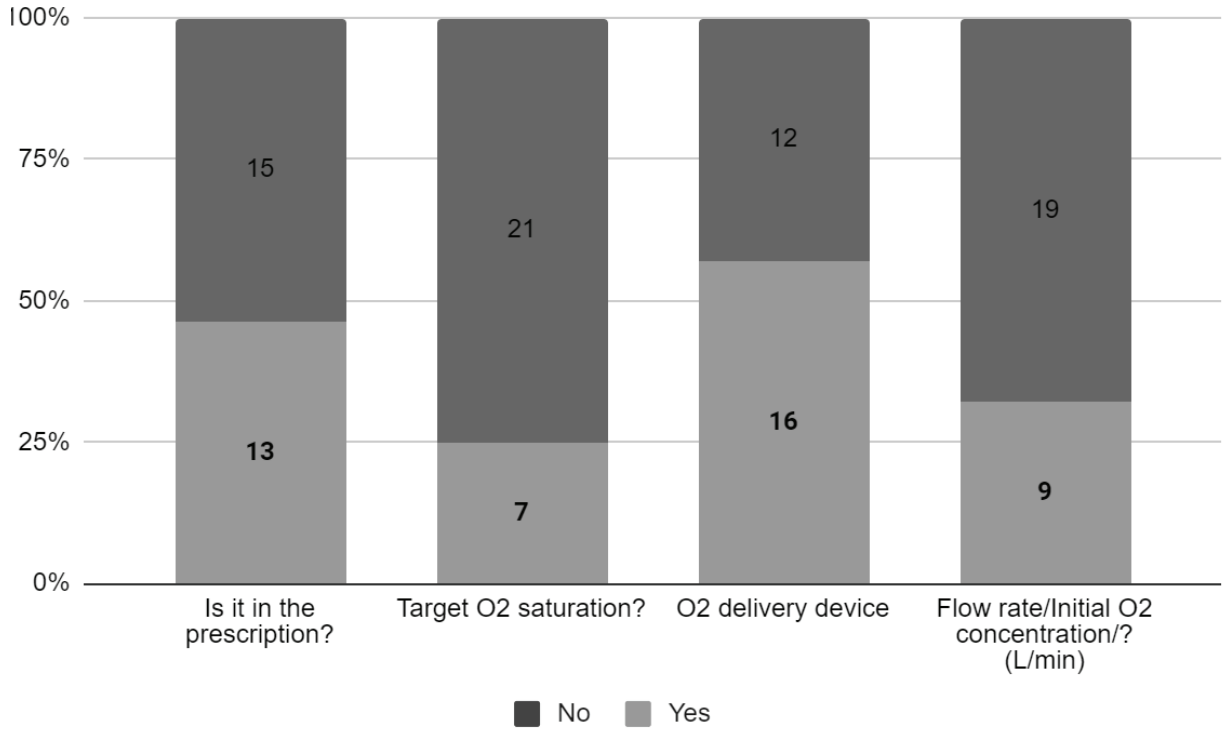

Figure 2. O_2 delivery devices used

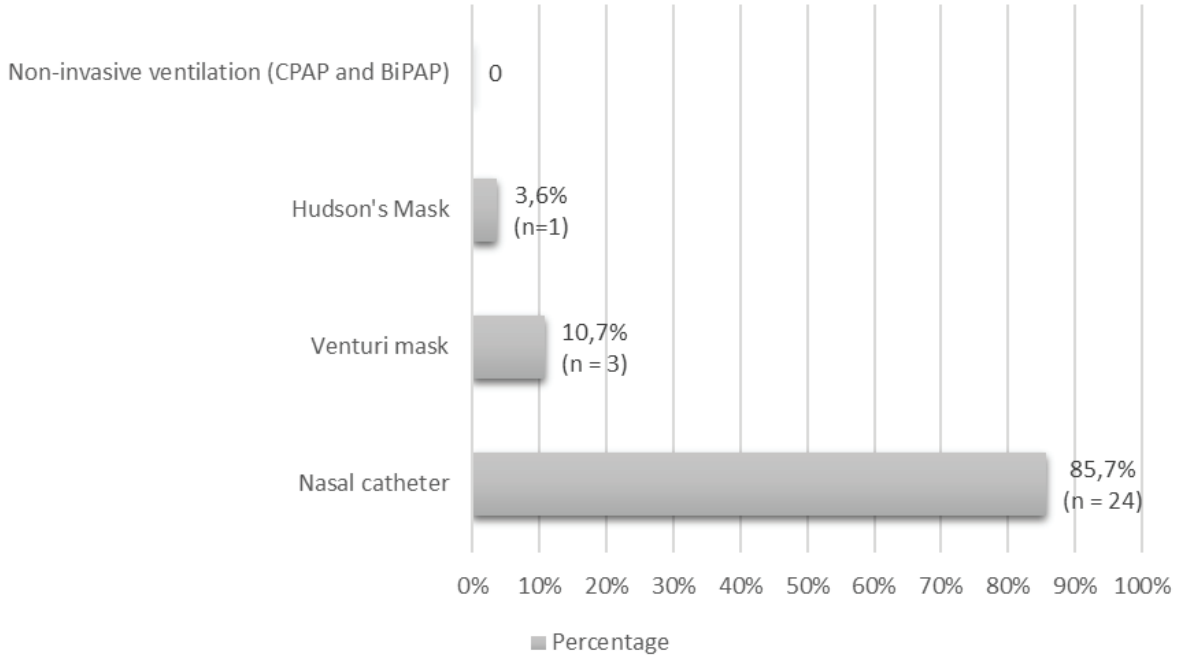

Table 1. Proposals for interventions suggested by the panel of experts (Sergipe).

Placement of signposts in the patient's bed with information about their target O_2 saturation
Instructing a multiprofessional care team about the importance of maintaining patient saturation within the defined goal, and not to seek 99%-100% saturation
Defining an oxygen prescription model containing the saturation information regarding target O_2 saturation, O_2 delivery device and initial O_2 flow rate or concentration
Proposing to the headquarters of the company in charge of managing the hospital that a model for the prescription of oxygen therapy be added to the hospital management system
If it is not possible to include the oxygen prescription in the hospital management system, defining a separate model for oxygen therapy prescription, to be included as an annex to the patient's medical record
Conducting training sessions with the multiprofessional team and also individually, by specialty, on safe and rational oxygen prescription
Instructing the care team to identify possible adverse reactions related to excessive oxygen use
Encouraging the notification of medication errors related to oxygen therapy, as well as adverse reactions, harmful effects, etc.
Reviewing and adjusting the current protocol on oxygen use in the institution

Discussion

As well as any other medication, medicinal oxygen should be employed in a safe and rational way, and only when there is an indication for its use. In hospitalized patients, cases in which oxygen use is very common, inclusion of the gas in the medical prescription, with the definition of all necessary criteria, can be an important ally in reducing potential harms caused by the inappropriate use of this medicinal gas, thus ensuring oxygen therapy safety and effectiveness[8,5].

However, the practice of oxygen prescription in Brazilian hospitals is not much studied, and it is not yet possible to define the quality of the prescriptions for this medicinal gas in the country. There is a record of a Brazilian study, conducted at a university hospital in São Paulo with patients under clinical and surgical care and published in the form of a letter to the editor, which shows initial results of the practice of oxygen therapy in that hospital[9]. In the study, the authors showed that oxygen was used inadequately, as it was continuously prescribed to most patients and, in addition, 97% of the surgical patients were unnecessarily administered oxygen in the postoperative period and a minority of the patients presented hypoxemia before initiation of oxygen therapy. Another study carried out in the same hospital, this time with pediatric patients with clinical signs of pneumonia, concluded that there was an improvement in the oxygen indication rates in relation to the study by Cogni *et al.*[9], using oxygen saturation < 90% and high respiratory rate as criteria for O_2 supplementation, according to pneumonia protocols and guidelines, indicating an improvement in the medical knowledge regarding clinical indications for O_2 supplementation[10]. Although the papers somehow portray the practice of oxygen therapy in the institution, the authors did not assess the quality of the oxygen prescriptions, a topic that is the object of this study.

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Oxygen administration should be reserved only for hypoxemic patients, with no defined benefits for oxygen supplementation in normoxemic patients, regardless of the associated clinical condition. In addition to that, there are also no studies that evidence oxygen use for symptom relief in dyspneic patients with normal O_2 saturation[6]. Our study showed that most of the patients evaluated had an indication for oxygen. These results are in agreement with the study by Al-Mobeireek and Abba[11], which showed that 52.8% of the patients had hypoxemia and an indication for oxygen, while in 17.6% of the patients the indication for O_2 supplementation was not clear. The high percentage of patients with an indication for oxygen therapy can be explained by the fact that the months of March to June 2021 coincide with the period of the second wave of COVID-19 cases in Brazil, and many patients were admitted to the hospital already on ventilatory support during this period. When the patients were discharged from intensive care, the majority was transferred to general practice and COVID-19 wards and was in the process of weaning from oxygen. For this reason, despite the high percentage of patients without information on initial oxygen saturation, it was considered that the majority had indications for the use of supplemental O_2 due to the reasons presented above.

A number of audits carried out at hospitals in several countries have evidenced that the medical prescriptions for oxygen are incomplete or do not comply with the recommendations set forth by the BTS or other institutions of the same nature[2,4,8,12-15]. Our study showed inadequacies in most of the items evaluated in the oxygen therapy prescriptions, mainly in relation to the inclusion of oxygen in the medical prescription, to the definition of the target saturation for each patient, and to the definition of the initial O_2 flow or concentration and demonstrated a higher compliance rate regarding presence of the O_2 delivery device.

However, even though this study presented results mostly contrary to the BTS guidelines, an audit performed at a rural hospital in Australia showed even lower compliance rates, in which only 17% of the patients had oxygen prescribed, 3.6% had the O_2 delivery device specified, and only 2.4% had the initial flow rate defined[2]. In another hospital from Western Australia, the authors found that, of the 65 patients evaluated in the study, 44.6% were administered oxygen without a prescription, only two patients had their target saturation defined (although this information was included somewhere else than in the medical prescription) and, in 37% of the patients, the initial O_2 saturation of before initiating the oxygen therapy was not reported. However, they did not evaluate presence of the delivery device or the initial O_2 flow rate or concentration[3].

Despite presenting different quantitative results, the studies corroborate that the oxygen prescriptions, not only in the reference hospital for this study but also in other parts of the world, do not comply with the good practices of oxygen therapy prescription. As determined in the Protocol for Safety in Prescription, Use and Administration of Medications published by the Brazilian Ministry of Health, in addition to other items, a safe prescription must contain information on dose, length of treatment, dosage and administration route[16]. Therefore, a complete oxygen prescription is fundamental to guarantee its administration according to the patient's needs and in a safe and effective way, thus reducing medication errors, adverse events and hospitalization times, in addition to being an intervention performed on the patient that needs to be recorded in the medical chart.

In a complementary way, definition of the saturation target in the prescription is also important to assess the need to use oxygen therapy, or the possibility for suspension or weaning. When a patient does not have a $SatO_2$ target defined, they may receive excessive oxygen therapy, which is associated with a higher risk of mortality, mainly in patients at risk of hypercapnic respiratory failure, or insufficient oxygen therapy[17]. Such being the case, it is imperative that all patients in use of supplemental oxygen are monitored and that oximetry is performed on a regular basis, which should be considered as the "fifth vital sign", so that oxygen is titrated to the target saturation defined[2,6]. In addition, the professionals' lack of knowledge about the target saturation for each patient can generate a tendency to maintain saturation between 99% and 100%. This situation may have contributed for this item to present the highest non-compliance percentage.

Although most of the patients in this study had the O_2 delivery device defined, a high percentage of subjects did not show compliance with this item in the prescription, and the percentage of patients without definition of the initial O_2 flow or inspired O_2 concentration was considerable. The delivery device and the initial O_2 flow/concentration must also be included in the medical prescription, as each device presents different oxygen flow profiles, also varying as to the presence or not of a reservoir system or a gas humidification device. In addition to that, its indication will depend on the patient's need and its target saturation defined, on the severity of hypoxemia, on the need for the inspired O_2 concentration control degree, and on the patient's tolerance to the device in use. For example, high-flow devices such as Venturi masks, should be carefully evaluated for patients at risk of carbon dioxide retention[18-21].

For the patients in this study with the oxygen delivery device determined, we observed that there was higher prevalence in the prescription of the spectacle-type nasal catheter, possibly because it is the easiest device to handle and the one the professionals know the most. Corroborating these results, based on a questionnaire, a study assessed physicians' and nurses' knowledge about oxygen delivery devices and their use in different clinical indications. The authors verified that the device that was most recognized by the professionals was the nasal cannula, for being the most commonly used[22].

Inadequacy of the prescriptions evaluated in this paper can be justified by non-recognition by the professionals that oxygen is a medication, and that, like any other, it has precise indications, that it must be safe in terms of its prescription, use and administration, and that it is not exempt from risks when used improperly. In addition to that, the absence of national guidelines that instruct the professionals regarding the correct way to prescribe and use oxygen may also be a contributing factor. Therefore, this is a scenario that can be modified through the development of guides or protocols at the local or national levels, which contain guidelines and contribute to the education of the professionals involved in the entire process of oxygen use regarding proper use and the need for a prescription to use oxygen therapy.

Previous studies had conducted audits before and after the interventions to evaluate their impact on quality regarding oxygen use, prescription and administration. The authors verified that, after performing educational actions, the implementation of a specific model for oxygen prescription and the creation of specific policies or guides for oxygen use, as well as the implementation of prescription reminders by the Nursing team, resulted in considerable improvements in the indices evaluated[2,7,12,14,15]. For this reason, considering that the institution where this study was carried out also needs improvements in the practice of oxygen use, it was proposed to assemble a panel of experts for the evaluation

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of reality and the preparation of proposals for interventions to be carried out at a later moment, enabling an *a posteriori* evaluation, in order to assess the impact on oxygen use in the hospital. From the interventions defined, the actions proposed will be carried out with the care professionals in order to evaluate whether the interventions will exert a positive impact on the profile of medicinal oxygen prescription, use and administration to patients hospitalized in the institution.

Despite being considered innovative in Brazil in the evaluation of the quality of oxygen prescriptions and presenting a potential to contribute to the importance of this theme in Brazil and to contribute to patient safety, this study presents as a limitation the fact that most patients were considered as with oxygen indications, as most of the patients evaluated were post-COVID-19, although the majority did not present information on saturation in the medical records before initiation of oxygen therapy.

Conclusion

This study showed that most of the patients did not have adequate oxygen prescriptions according to the British Thoracic Society (2017) guidelines. Although most patients complied with the oxygen therapy indication, most of the items evaluated in the oxygen prescriptions were non-compliant, as shown in audits conducted at other hospitals worldwide. Based on these results, it was possible to identify opportunities for improvements in oxygen therapy use and prescription and to schedule interventions with the multiprofessional team involved in the entire process of medicinal oxygen use, envisioning greater safety for the patients undergoing oxygen therapy and reduction of care-related costs. Consequently, regarding future perspectives, the intention is to conduct a new study to evaluate the impact of the interventions proposed.

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Collaborators

Authors BSL, MLB and FJRA took part in elaboration of the project; BSL, MLB GUO, DTO, LMA, SMS, GCC, MMX, MCS and FJRA contributed in data analysis and interpretation and in review of the final text; and BSL, GUO and FJRA participated in writing of the article. All the authors approved the final version of the manuscript.

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Conflict of interest statement

The authors declare that there are no conflicts of interest in relation to this article.

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