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Evaluation of oxygen therapy provided to adult inpatients in a hospital unit following interventions involving the multidisciplinary team

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Abstract

Objective: To evaluate the oxygen therapy offered to adult patients admitted to a hospital unit regarding compliance with the guidelines of the British Thoracic Society, after interventions with the multidisciplinary team, focusing on improving work processes. **Methods:** This is an uncontrolled intervention study (Before and after), which was divided into three stages: (1) planning and execution of interventions, (2) collection of data and medical records and prescriptions at two moments, and (3) comparison of pre and post intervention results. **Results:** the sample consisted of 15 patient records in the pre-intervention period and 23 records in the post-intervention period. The item of the medical prescription with the highest percentage of improvement was "target saturation", which increased from 13% to 61% compliance at the end of the analyses. **Conclusion:** the present study demonstrated advances in the adequacy of oxygen therapy regarding the established parameters; however, there are still several opportunities for improvement in adherence to the institutional protocol implemented during this study. It is expected that this study will contribute to the promotion of the safe, rational and optimized use of oxygen therapy.

Keywords: Oxygen Inhalation Therapy; Controlled Before-After Studies; Hospitals; Medical Records.

Avaliação da oxigenoterapia ofertada para pacientes adultos internados em uma unidade hospitalar após intervenções junto à equipe multiprofissional

Resumo

Objetivo: avaliar a oxigenoterapia ofertada para pacientes adultos internados em uma unidade hospitalar quanto ao cumprimento das diretrizes da *British Thoracic Society*, após intervenções junto a equipe multiprofissional. **Métodos:** trata-se de um estudo de intervenção não controlada (antes e depois), realizada em três etapas: (1) planejamento e execução das intervenções, (2) coleta de dados e dos prontuários e prescrições médicas e (3) comparação dos resultados pré e pós intervenção. **Resultados:** a amostra foi composta por 15 prontuários de pacientes no período pré-intervenção e 23 prontuários no pós-intervenção, o item da prescrição médica com maior percentual de melhoria foi a "saturação alvo", que avançou de 13% para para 61% de conformidade ao fim das análises. **Conclusão:** o presente estudo evidenciou avanços na adequação da oxigenoterapia quanto aos parâmetros estabelecidos, no entanto ainda existem diversas oportunidades de aprimoramento na adesão ao protocolo institucional implementado durante este estudo. Espera-se que este estudo contribua para a promoção do uso seguro, racional e otimizado da oxigenoterapia.

Palavras-chave: Oxigenoterapia; Estudos Controlados Antes e Depois; Hospitais; Prontuário

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Introduction

The regulation of medical gases as medicines occurred as a major "domino effect," first in Europe, beginning with France in 1992, followed by all European Union countries through a harmonization process of regulation. In 1995, this regulation was implemented in North America, while in South America, Argentina was the pioneering country in 1999, followed by Uruguay, Chile, Colombia, Ecuador, Peru, and Venezuela. Brazil only regulated the use of medical gases as medicines in 2008, through Collegiate Board Resolutions (RDC) No. 70/2008 and No. 69/2008. Currently, in Brazil, the regulations in force regarding registration and notification and good manufacturing practices for medical gases are RDC No. 870/2024 and RDC No. 658/2022, respectively, which established the minimum requirements for ensuring the quality, safety, and efficacy of medical gases, as well as good manufacturing practices.[1,2]

According to Anvisa's definition (2020), medical gases are "medicines in the form of gas, liquefied gas, or cryogenic liquid, isolated or combined with each other, and administered to humans for the purposes of medical diagnosis, treatment, or disease prevention, as well as for the restoration, correction, or modification of physiological functions." Among medical gases, oxygen stands out due to its widespread use and the fundamental role it plays in healthcare.[3,4]

The clinical use of oxygen is called oxygen therapy, which promotes tissue oxygenation in cases of hypoxia. Its indication is generally related to patients presenting some respiratory disorder associated with an underlying disease or metabolic imbalance due to pathological complications, such as chronic obstructive pulmonary disease, pulmonary fibrosis, or other conditions such as COVID-19, by supporting cell function and metabolism and reducing the likelihood of organ dysfunction. It is also widely used in anesthesia during surgical procedures, in diagnosis, as a carrier for drug administration via inhalation or nebulization, and in cardiopulmonary resuscitation.[4,5]

Inappropriate use of oxygen can cause serious consequences, such as increased partial pressure of CO_2 (pCO_2) leading to hypercapnic respiratory failure, hypercapnia-induced narcosis, absorption atelectasis, direct pulmonary toxicity, increased systemic vascular resistance and blood pressure, reduced coronary artery blood flow, reduced cardiac output, decreased cerebral blood flow, and death.[6,7] Therefore, the involvement and collaboration of professionals from various fields, working in an integrated manner, are essential to ensure comprehensive patient care.

The British Thoracic Society has developed guidelines for safe oxygen therapy, applicable through clinical criteria and parameters for patient use of the medication, which should be assessed during administration, including the specification in the medical prescription of target oxygen saturation, delivery device, and initial flow.[8]

A situational diagnostic study conducted by Santos et al. (2022), through the evaluation of oxygen therapy prescriptions of patients under clinical care admitted to the University Hospital of the Federal University of Sergipe, identified a scenario in which most hospitalized patients did not have oxygen prescriptions in compliance with the British Thoracic Society guidelines, with inconsistencies in all evaluated items.[4,9] Based on this analysis, opportunities for improvement were identified and proposed by a panel of experts in order to reduce potential patient risks, ensure greater safety during hospitalization, and contribute to the reduction of institutional costs. In this context, the aim of this study is to evaluate oxygen therapy provided to adult inpatients in a hospital unit regarding compliance with the British Thoracic Society guidelines, after interventions with the multiprofessional team.

Methods

This is an uncontrolled intervention study (before-and-after), conducted at the University Hospital of the Federal University of Sergipe, and divided into three stages: (1) planning and implementation of the interventions; (2) data collection from medical records and prescriptions at two different time points; and (3) analysis of the results.[10-15]

This study is part of a broader research project entitled *"Medical Gases: validation of an instrument, hospital use profile, and identification of problems related to these medicines,"* approved by the Research Ethics Committee Involving Human Subjects under opinion No. 3.709.534 (CAAE No. 22984119.9.0000.5546).

First stage

The planning of the interventions for this study was carried out using the 5W2H tool.[19] The interventions performed included: (1) drafting and validation of the hospital's oxygen therapy protocol; (2) development and integration of oxygen into the electronic prescription system used at the hospital; (3) drafting, validation, and production of signage boards for target oxygen saturation ranges; and (4) training sessions with the multiprofessional team. The intervention planning according to the 5W2H tool is described in the supplementary material.

The intervention was implemented with the multidisciplinary team involved in patient care under oxygen therapy, which generally consists of nurses, pharmacists, physical therapists, physicians, and nursing technicians. The activities were carried out between June and November 2023. The hospital units participating in this study were Medical Clinics I and II, Surgical Clinics I and II, and Oncology.

The institutional protocol was developed based on the guidelines of the British Thoracic Society (2017) and the recommendations of the Thoracic Society of Australia and New Zealand (2017). The protocol includes the following activities: (1) hand hygiene; (2) use of personal protective equipment; (3) patient identification, patient assessment, arterial blood gas analysis, oxygen prescription in the hospital's electronic system, installation of the delivery device and the target saturation board, documentation of procedures in the medical record, patient monitoring, adjustment of oxygen flow (titration), and provision of health education on oxygen therapy to patients and caregivers.

According to the protocol, the medical prescription should include at least three essential elements: the delivery device, the flow range, and the target oxygen saturation. To standardize clinical practices, three saturation ranges were defined for prescription: 88–92%, 92–96%, and an additional range at the physician's discretion, according to the patient's clinical needs. Based on these ranges, three specific oxygen therapy signage models were developed with their respective target saturations (Figure 1), in order to facilitate adherence to the protocol and standardization of care.

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Figure 1. Target saturation signage boards.

Despite the recognition of oxygen as a medicine, it was found that the hospital management system did not allow its inclusion in the medication prescription field. To overcome this limitation, an alternative approach was adopted by prescribing it in the "care" field, which required specific adaptations to ensure standardization and clarity of instructions. This solution aimed to guarantee that oxygen could be prescribed in accordance with the protocol guidelines while minimizing variability in clinical practice.

The training sessions with the multiprofessional team were directed at nurses, nursing technicians, physicians, physical therapists, and pharmacists from all sectors involved in the study, across all three daily shifts, with the objective of ensuring the proper and consistent implementation of the oxygen therapy protocol. During the training, topics addressed included the importance of the protocol, correct use of the signage boards, complete and safe prescription of oxygen therapy, possible adverse reactions, and the importance of reporting such events.

Second stage

Following the interventions, data were collected from medical records, medical prescriptions, and bedside observations, covering all elements defined for analysis. In the prescription, the following were verified: prescribed medicine, target oxygen saturation, oxygen delivery device, prescriber's name and signature, date, and flow (L/min) or fraction of inspired oxygen. In the medical record, the presence of an underlying disease justifying reduced SpO_2 and the indication for the medicine based on prior saturation were analyzed. At the bedside, the presence of signage boards indicating the target saturation in use was assessed.

Data collection from medical records and prescriptions was carried out retrospectively, covering the entire period from the beginning of oxygen therapy to hospital discharge, regardless of the clinical outcome. Bedside observations aimed to verify the presence and adherence to the target saturation signage boards. With the support of daily records of patients receiving oxygen therapy in the hospital's rehabilitation unit, all patients undergoing this therapy during the collection period were included in the study, regardless of whether it was documented in the medical prescription. The total study population represented 100% of patients who met this criterion during the month of data collection.

Data were collected at two distinct time points: May 2023, before the interventions, and May 2024, after implementation of the interventions. The choice of corresponding months was motivated by the need to control for possible seasonal variations (such as changes in the epidemiological profile of respiratory diseases, variations in hospitalization rates, or greater oxygen use during certain periods of the year), thereby improving comparability between pre- and post-intervention data and enabling the identification of significant modifications in the results, while assessing the effectiveness and persistence of the interventions over time.

To ensure inclusion of prescriptions in the analysis, the criteria "date" and "prescriber's signature" were initially checked, used only as eligibility parameters and not analyzed as comparative outcomes. To assess the indication for oxygen therapy, medical, nursing, and physical therapy notes were reviewed to identify the initial saturation at which the patient was prior to receiving supplemental oxygen. Oxygen therapy was considered indicated for patients with SpO_2 <92% or <88% (for those at risk of hypercapnic respiratory failure) and/or when PaO_2 was below 60 mmHg, in addition to patients who were admitted already intubated or receiving oxygen through other devices.[11,20]

Prescriptions that were adjusted more than 24 hours after the initiation of oxygen therapy were also considered appropriate.

Third stage

The pre-intervention and post-intervention results were obtained, tabulated, compared, and assessed regarding compliance with the institutional protocol, which was developed based on the guidelines of the British Thoracic Society (2017) and the Thoracic Society of Australia and New Zealand.[9,16]

Data were tabulated in Microsoft Excel® 2019 spreadsheets and analyzed using Fisher's exact test and the Chi-square test, with the support of the ChatGPT artificial intelligence system (OpenAI)®, in addition to descriptive statistics.

Results

The institutional protocol was published on the hospital network intranet, with free access to all healthcare professionals. More than 140 multiprofessional staff members from all hospital sectors responsible for adult patients participated in the training sessions. A total of 38 medical records were evaluated: 15 in the first data collection (pre-intervention) in May 2023 and 23 in the second collection (post-intervention) in May 2024. Adherence to the use of target saturation signage boards at patient bedsides was also assessed; 12 patients were visited, and only 42% (n = 5) had a signage board at the bedside.

In the pre-intervention data, 87% (n = 13) of cases had a formal indication for oxygen therapy, as documented in the medical record before treatment initiation. It was also observed that 80% (n = 12) of oxygen therapies were properly prescribed, 7% (n = 1) were prescribed only after more than 24 hours of use, and 13% (n = 2) had no prescription. Target oxygen saturation was recorded in only 13% (n = 2) of prescriptions, which were the only ones consistent with the British Thoracic Society criteria.

Regarding the delivery device, 67% (n = 10) were correctly prescribed, 27% (n = 4) had no record, and 7% (n = 1) were prescribed after more than 24 hours of use. With respect to initial flow, 47% (n = 7) were appropriately prescribed, 47% (n = 7) had no record, and 7% (n = 1) were prescribed only after more than 24 hours of use. The percentage of prescriptions containing all required items was 13% (n = 2).

In the post-intervention period, 61% (n = 14) of cases presented a formal indication for oxygen therapy, while 13% (n = 3) had no indication. However, in 26% (n = 6) of cases, there were no records or sufficient data in the medical charts to assess the formal indication for therapy, making the analysis and comparison of interventions in this aspect more difficult. The pre- and post-intervention comparison of this item is illustrated in Figure 2. Regarding medical prescriptions, 74% (n = 17) of oxygen therapies were properly prescribed, 9% (n = 2) were never prescribed during hospitalization, and 17% (n = 4) were prescribed only after more than 24 hours of therapy initiation. An improvement was observed in the documentation of target oxygen saturation, with 39% (n = 9) properly prescribed at the initial time, 22% (n = 5) prescribed after more than 24 hours, and 39% (n = 9) with no prescription. Concerning the delivery device, 43% (n = 10) were adequately documented in prescriptions, 22% (n = 5) were prescribed after 24 hours, and 35% (n = 8) had no record. As for flow, 48% (n = 11) were prescribed, 13% (n = 3) were documented after more than 24 hours, and 39% (n = 9) had no prescription. The percentage of prescriptions containing all required items was 39% (n = 9).

The final comparative analysis of pre- and post-intervention results, considering adjustments after 24 hours, is presented in Figures 2 and 3, which include the results of statistical significance (p) and the test used for each variable. Statistical significance was found only for the item "target saturation."

Figure 2. Comparison of indications for oxygen therapy before and after the interventions with the multiprofessional team at the University Hospital of the Federal University of Sergipe, Sergipe, 2024.

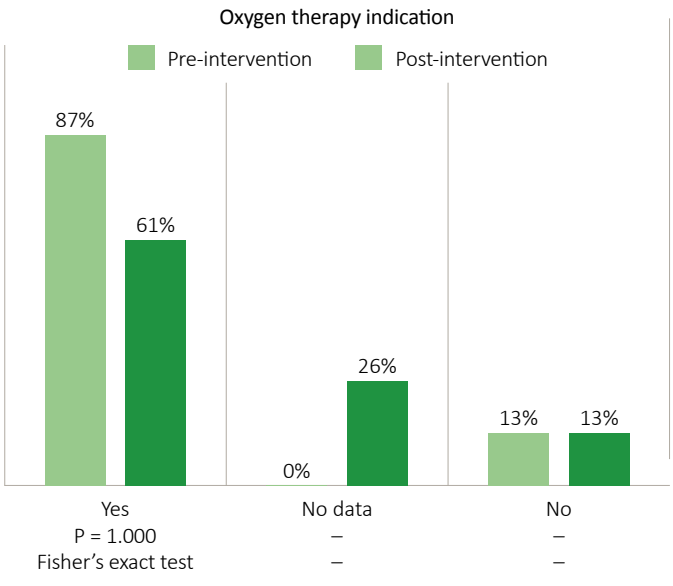
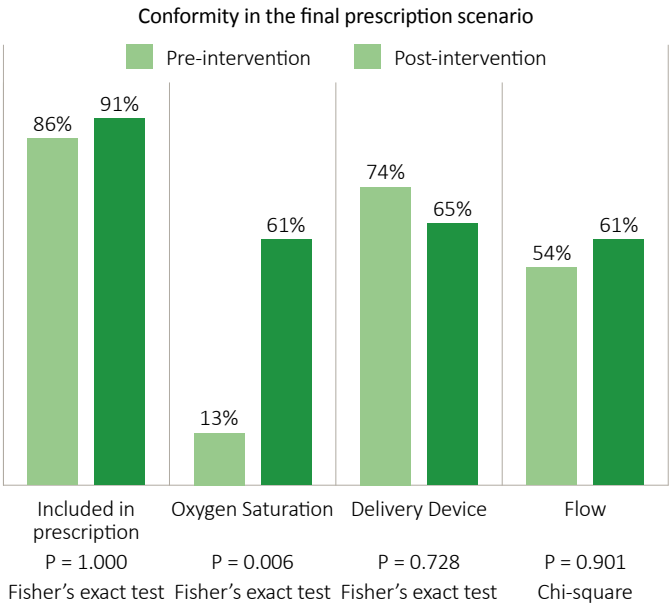


Figure 3. Compliance in the final prescription scenario: comparison before and after the intervention with the multiprofessional team at the University Hospital of the Federal University of Sergipe, Sergipe, 2024.



Discussion

The data retrieved from prescriptions and patient records for those undergoing oxygen therapy in the pre-intervention period show similarities with the findings reported by Santos et al. (2022), who identified opportunities for improvement in oxygen therapy management during the Covid-19 pandemic in the same hospital.[6] This pattern of incomplete or inadequate prescriptions is not restricted to the local setting, but has also been widely reported in hospitals across different countries, as evidenced by multiple studies worldwide that point to frequent failures in complying with the guidelines recommended by the British Thoracic Society (BTS).[10-15,17] These findings reinforce the need for multicomponent interventions and indicate that the sustainable incorporation of institutional policies—including regular training, continuous monitoring of compliance, and the possible implementation of electronic alert systems—may be crucial to improving adherence to oxygen therapy guidelines, particularly in critically ill patients, for whom strict target saturation management is essential.

Among the minimum elements recommended by the BTS for oxygen therapy prescriptions, the target oxygen saturation—considered one of the most relevant parameters—showed the most unsatisfactory results during the pre-intervention period. Post-intervention data, however, demonstrated improvements in this parameter, which was the only component of the prescription to show significant progress. Considering that it represents the main parameter for the safety of oxygen therapy, this improvement suggests that practice in the hospital became more aligned with the guidelines and potentially safer for patients. The analysis of prescription completeness also revealed an increased rate of protocol compliance, although further progress is still needed to achieve full adherence to the established guideline.

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It was also noted that, after the interventions, a greater number of prescriptions were adjusted after more than twenty-four hours, showing improvements in terms of protocol compliance. This finding may be interpreted as a positive effect, possibly resulting from the work of the multidisciplinary team—composed of clinical pharmacists, nurses, and physiotherapists trained during the study—and is consistent with the results described by Watson et al.[13] Considering that the prescription system is controlled by the medical team, it is plausible that these adjustments were influenced by the interventions performed, reinforcing the importance of involving different professionals in optimizing oxygen therapy.

The target saturation boards implemented after the intervention showed partial adherence (42%). Although these rates remain below the ideal, their presence represents progress compared to the pre-intervention scenario, in which no standardized visual guidance tool was available. Possible reasons for this level of adherence include staff turnover, communication failures among care team members, and the probable perception of low practical relevance by professionals when faced with competing clinical demands. This result highlights the importance of ongoing strategies to promote staff engagement and consolidate practices aimed at patient safety.

Other studies also employed an intervention model and compared results before and after the implementation of an institutional protocol and training for healthcare professionals. The findings indicated only partial improvement in the prescription and use of oxygen therapy after the interventions, with reductions in protocol adherence over time, in oxygen titration, and in prescriptions.[12,13,15,17] These results may suggest that the simple one-time introduction of guidelines may not be sufficient to promote sustainable changes in clinical practice.

The study by Lagan et al. previously identified inadequacies in prescriptions and reported a significant improvement after the implementation of interventions, which included continuous training and monitoring of guideline adherence over time. This may have contributed to greater effectiveness in modifying clinical practices.[14] Unlike the studies by Wheeler et al.,[12] Gunathulake et al.,[13] O'Driscoll et al.,[15] and Wijesinghe et al.,[17] which relied on one-time training sessions, the use of ongoing training may be even more beneficial in hospitals with profiles similar to that of this study, given that it is a teaching hospital that regularly receives students and residents from various professions. Such a practice can promote sustainability, ensure the dissemination of information, and foster the training of new generations of healthcare professionals.

Studies suggest that one of the factors contributing to the high prevalence of inadequate prescriptions is the complexity of the prescribing process itself, which can act as a limiting factor for adherence to recommendations.[10,11] Furthermore, unlike other drugs, oxygen is always readily available in hospitals and can be administered immediately without the need for a formal order.[10] This corroborates the findings of our study, which revealed patients receiving oxygen without the corresponding prescription. In addition, the absence of oxygen in the "medications" section of the institutional prescription system may represent a barrier to adherence to the protocol, as it does not highlight the need for its formal prescription. Improvement proposals for the electronic system were formalized to categorize oxygen as a medication, thereby facilitating its prescription and monitoring, as well as indirectly increasing healthcare professionals' accountability regarding oxygen therapy prescriptions.

During the training stage, several limitations were identified. In some hospital sectors, participation in training was not fully satisfactory. Despite prior communication and notification about the sessions, some professionals did not attend, which compromised the uniformity of protocol adherence across all areas. This highlighted the need for more effective strategies to ensure engagement and participation from all members of the multidisciplinary team. Another limiting factor may be related to the fact that nurses, physiotherapists, and physicians can initiate, monitor, and adjust oxygen therapy; however, only physicians are authorized to change the prescription. This dynamic may contribute to the omission or neglect of prescription documentation. Moreover, a significant challenge was the limited time available for reviewing prescriptions and patient records, which was restricted to just one month, six months after the interventions, potentially influencing both the scope of the analysis and the observed results.

Conclusion

This study demonstrated improvements in the standardization of oxygen therapy prescriptions following the implementation of interventions targeting the multidisciplinary team, with significant results particularly in target saturation recording and in the adoption of target saturation boards. Nevertheless, partial adherence to the guidelines highlighted the persistence of shortcomings, with factors such as staff turnover and limited participation in training sessions likely contributing to the suboptimal compliance, emphasizing the need for continuous strategies to strengthen adherence to the institutional protocol.

It is expected that this study may also serve as a model for planning interventions aimed at optimizing oxygen therapy in other institutions, both public and private. Furthermore, it is hoped that this study will contribute to the literature by consolidating research on the appropriateness of oxygen use in hospitals, in addition to promoting its safe and rational use. Finally, disseminating the findings to the national and international technical-scientific community may support the development of more effective policies for oxygen therapy practice in hospitals, as interventions in this area are essential to positively transform it, making it safer and more cost-effective.

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Contributors

Authors PWSM, FJRA, and SMS participated in the project design, planning, implementation of interventions, manuscript drafting, and revision of the final text. GCC, LMA, and EFLA contributed to the planning and implementation of the interventions carried out in the study.

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Conflict of Interest Statement

The authors declare no conflicts of interest.

Artificial Intelligence (AI) Systems

During the study, an artificial intelligence system was used to support the drafting and revision of this manuscript. The use of AI was strictly limited to linguistic improvement suggestions and assistance with statistical tests, without interfering with the methodology or results of the research.

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