BioSCIENCE
Review Article
DOI: https://doi.org/10.55684/2025.83.S2.e00013

Evaluation of the clinical impact of smart oximeters in patients with chronic obstructive pulmonary disease (COPD)

Avaliação do impacto clínico de oxímetros inteligentes em pacientes com doença pulmonar obstrutiva crônica (DPOC)

Gabriel Mathias Vitoreti[1], Homero Grein Neto[1], Mariana Tiboni Nacamura[1], Luiz Eduardo Latorre Guimarães[1]

ABSTRACT

Introduction: Chronic obstructive pulmonary disease is a global public health challenge, being one of the leading causes of morbidity and mortality worldwide. Its effective management is essential to improve quality of life and reduce the burden on healthcare systems.

Objective: To critically evaluate the scientific literature to determine the clinical impact of the use of smart oximeters in the control of this disease.

Method: Systematic review of PubMed and ScienceDirect databases, selecting original studies and reviews published since 2015, in Portuguese or English, with full text available, that investigated the use of smart oximeters in patients.

Result: 10 studies were included.

Conclusion: Monitoring with smart oximeters is associated with a reduction in the frequency of acute exacerbations, hospitalization rates, and improved quality of life. Thus, they demonstrate significant potential to improve disease management. However, future studies should address implementation challenges, such as data integration and technological accessibility.

KEYWORDS: Oximetry. Chronic obstructive pulmonary disease. COPD. Clinical effectiveness.

Central Message

Traditionally, continuous monitoring of oxygen saturation has occurred in clinical settings or by home visits, which may be limited in terms of frequency and access. With the advancement of technology and the popularization of wearable devices, smart oximeters emerge as tools capable of performing continuous measurements and transmitting data to health platforms, enabling remote and proactive monitoring.

Perspective

The implications of these findings suggest that the adoption of smart oximeters can transform COPD care, leading to more proactive management, reduced healthcare costs associated with exacerbations and hospitalizations, and substantial improvement in patient well-being and autonomy.

RESUMO

Introdução: A doença pulmonar obstrutiva crônica é desafio de saúde pública global, sendo uma das principais causas de morbidade e mortalidade em todo o mundo. Sua gestão eficaz é essencial para melhorar a qualidade de vida e reduzir a carga sobre os sistemas de saúde.

Objetivo: Avaliar criticamente a literatura científica para determinar o impacto clínico do uso de oxímetros inteligentes no controle dessa doença.

Método: Revisão sistemática nas bases PubMed e ScienceDirect selecionando estudos originais e revisões publicados a partir de 2015, em português ou inglês, com texto completo disponível, que investigaram o uso de oxímetros inteligentes nos pacientes.

Resultado: Foram incluídos 10 estudos.

Conclusão: O monitoramento com oxímetros inteligentes está associado à redução na frequência de exacerbações agudas, nas taxas de hospitalização e melhora na qualidade de vida. Assim, os eles demonstraram potencial significativo para melhorar o manejo da doença. Contudo estudos futuros devem abordar desafios de implementação, como a integração de dados e a acessibilidade tecnológica.

PALAVRAS-CHAVE: Oximetria. Doença pulmonar obstrutiva crônica. DPOC. Efetividade clínica.

[1] *Evangelical Mackenzie Faculty of Parana, Curitiba, PR, Brazil.*

Conflict of interest: None | Funding: None | Received: 10/08/2025 | Accepted: 27/10/2025 | Publication date: 28/11/2025 | Correspondence: gvitoreti03@gmail.com | Associate Editor: Nerlan Tadeu Gonçalves de Carvalho

How to cite:
Vitoreti GM, Grein Neto H, Nacamura MT, Guimarães LEL. Avaliação do impacto clínico de oxímetros inteligentes em pacientes com doença pulmonar obstrutiva crônica (DPOC). BioSCIENCE. 2025;83(S2):e00013

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a global public health challenge, being one of the leading causes of morbidity and mortality worldwide. Characterized by persistent airflow limitation, usually progressive, it is associated with chronic inflammatory response of the airways and lung parenchyma to harmful particles or gases. Their effective management is essential to improve quality of life and reduce the burden on health systems. One of the pillars of this management is the continuous monitoring of oxygen saturation (SpO_2), a vital indicator of respiratory function that can early signal acute exacerbations.[1]

Traditionally, SpO_2 monitoring has taken place in clinical settings or by home visits, which can be limited in terms of frequency and access. With the advancement of technology and the popularization of wearable devices, smart oximeters emerge as tools capable of performing continuous measurements and transmitting data to health platforms, enabling remote and proactive monitoring. These devices represent a promising frontier in telemedicine, transforming the follow-up of patients with COPD. The incorporation of smart oximeters into the COPD routine is relevant because it provides real-time data, facilitating the early identification of clinical deteriorations and exacerbations. This can lead to rapid interventions, reducing hospitalizations, emergency room visits, and promoting self-management of the disease. In addition, continuous monitoring provides valuable information to adjust treatment plans and optimize oxygen therapy.[2-5]

The objective of this systematic review was to critically evaluate the scientific literature in order to determine the clinical impact of the use of smart oximeters in patients with COPD, investigating outcomes such as frequency of exacerbations, hospitalizations, quality of life, treatment adherence, and patient satisfaction, in order to support clinical decisions and future research.

METHOD

This systematic review was designed following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

The search was conducted in the PubMed (including Medline) and ScienceDirect databases. The strategy used controlled descriptors (DeCS/MeSH) and free terms, combined with Boolean operators (AND, OR). The descriptors included: "Smart oximeters" OR "Wearable oximeters" OR "Remote pulse oximetry"; "COPD" OR "Chronic obstructive pulmonary disease"; "Remote monitoring" OR "Telemonitoring" OR "Telemedicine"; "Clinical outcomes" OR "Hospitalization" OR "Exacerbation" OR "Quality of life" OR "Patient reported outcomes". The search string has been adapted for each base, maintaining the essence of the terms.

Eligibility criteria

Articles that met the following types of studies were included: originals (randomized clinical trials, cohorts, case-control, prospective observational) and systematic reviews. They followed the following PICO guidance:

- Population: Adult patients (>18 years) with a confirmed diagnosis of COPD.
- Intervention: Use of smart oximeters or remote pulse oximetry devices for
- home monitoring.
- Comparator: Usual care, absence of remote monitoring, or other forms of
- Monitoring.
- Outcome: Frequency of exacerbations, hospitalizations, emergency room visits, quality of life (assessed by validated instruments), treatment adherence, patient satisfaction, or healthcare costs.

The publication period should be from January 1st 2015 to May 2025. The accepted languages were Portuguese and English. It should be available as full text. Articles that did not address smart oximeters or COPD, studies focused only on technical aspects of the devices, letters to the editor, conference abstracts without full text, and duplicate publications were excluded.

The selection was carried out in stages: 1) identification: titles and abstracts imported into reference management software (Mendeley) for removal of duplicates; 2) screening: evaluation of titles and abstracts, applying the inclusion/exclusion criteria; 3) Eligibility: full texts; 4) inclusion: articles that met all criteria. The quality of randomized controlled trials was assessed using the Cochrane Risk of Bias tool; observational studies were assessed using the Newcastle-Ottawa Scale (NOS); discrepancies were resolved by consensus among 2 reviewers.

Statistical analysis

The data were synthesized narratively, grouped by outcome and characteristics of the intervention. When possible, a meta-analysis was performed using the DerSimonian and Laird random-effects model. Heterogeneity was assessed by the I^2 test (0–40% = insignificant; 30–60% = moderate; 50–90% = substantial; 75–100% = considerable) and by the Cochran Q test, where $p<0.10$ indicates significant heterogeneity. Results were presented with 95% confidence intervals (95% CI) and $p<0.05$ for significance. Sensitivity analyses were conducted when necessary.

RESULT

The search, carried out in May 2025, retrieved 1,237 articles (PubMed: 689; ScienceDirect: 548). After removing 412 duplicates, 825 articles were screened by title and abstract. Of these, 765 were excluded, leaving 60 for evaluation of the full text. After applying the criteria, 10 studies were included: 2 randomized controlled trials (RCTs), 3 observational/cohort studies, 2 systematic reviews, 2 guidelines/statements, and 1 opinion article, all published between 2015 and 2024. Methodological quality revealed a low to moderate risk of bias in RCTs. Observational studies have obtained good quality in the NOS scale.

TABLE — Preferred metadata of the review carried out[1-10]

Author (Year)	Title/Type	Goals	Conclusion/Relevance
Ambrosino et al. 2016[1]	Declaration (ERS)	Provide a statement on telemonitoring for ventilator-dependent patients.	Telemonitoring is feasible and effective for subgroups of patients, including COPD, improving adherence and allowing for early intervention.
Aranburu-Imatz et al. 2022[2]	Systematic Review	To evaluate nurse-led interventions in patients with COPD.	Telemonitoring interventions (including oximetry) reduce hospitalizations and improve quality of life.
GOLD 2024[3]	Global Guideline	Strategy for diagnosing, managing, and preventing COPD.	It defines the management of COPD, highlighting the importance of monitoring symptoms and exacerbations.
Hardinge et al. 2015[4]	Cohort Study	To evaluate a mobile health app for COPD self-management (including oximetry).	The app was associated with an improvement in quality of life (CAT) and increased patient confidence in self-management.
Ho et al. 2016[5]	Randomized Controlled Trial (RCT)	To determine the effectiveness of telemonitoring (including SpO_2) in COPD patients in Taiwan.	Telemonitoring significantly reduced emergency room visits and improved quality of life, with high satisfaction (90%).
McDowell et al. 2015[6]	Randomized Controlled Trial (RCT)	To evaluate the effectiveness of telemonitoring home care (SpO_2) in patients with COPD.	It found a 25% reduction in hospitalizations (RR: 0.75) in the telemonitoring group compared to usual care.
Pinnock & McKinstry 2016[7]	Paradigm/Opinion Article	Discuss the promise and challenges of digital technology in respiratory diseases.	Digital technology (including oximeters) has potential, but it requires a paradigm shift for effective integration.
Sanchez-Morillo et al. 2016[8]	Systematic Review	To review the use of predictive algorithms in home monitoring of COPD and asthma.	Algorithms that use data from monitors (such as oximeters) can effectively predict exacerbations.
Segrelles-Calvo et al. 2015[9]	Observational Study (PROMETE)	To evaluate a home telecare program (with oximetry) for severe COPD.	The program significantly reduced hospital readmissions at 12 months (30% fewer readmissions
Shah et al. 2017[10]	Observational Study	Identify and predict COPD exacerbations using a digital health system (including SpO_2).	Continuous digital monitoring of vital signs, including SpO_2, can identify physiological changes days before an exacerbation.

Frequency of acute exacerbations

Two studies focused specifically on the ability of digital systems to predict exacerbations. A systematic review on predictive algorithms concluded that models using household monitoring data (including oximetry) are effective in predicting these events.[8] Shah et al.[10] demonstrated that a digital health system monitoring SpO_2 was able to identify predictive physiological changes days before the onset of a patient-reported exacerbation.

Rate of hospitalizations and emergency room visits

Three primary studies and 1 systematic review reported reductions in hospitalisations or emergency room visits. McDowell et al.[6] in RCTs, found a 25% reduction in hospitalizations in the telemonitoring group (RR: 0.75). Segrelles-Calvo et al.[9] reported 30% fewer hospital readmissions at 12 months in patients with severe COPD using telecare. Ho et al.[5] also observed a significant reduction in emergency room visits. The review by Aranburu-Imatz et al.[2] corroborated that telemonitoring interventions are associated with lower hospitalization rates.

Health-related quality of life

Three studies assessed quality of life. Ho et al.[5] reported significant improvement in quality of life in the intervention group. Hardinge et al.[4] evaluating mobile health app with oximetry, also noticed improvements in the COPD Assessment Test (CAT) score. This was supported by the systematic review by Aranburu-Imatz et al.[2] that associated telecare with improvements in quality of life.

Treatment adherence and patient satisfaction

Satisfaction and adherence were high in studies that measured these outcomes. Ho et al.[5] reported 90% satisfaction with the telemonitoring system. Hardinge et al.[4] observed that patients felt more confident in self-management of the disease using mobile technology. A statement from the European Respiratory Society also highlighted that telemonitoring improves adherence.[1]

Challenges and barriers

Despite the benefits, barriers were identified. Pinnock & McKinstry argue that digital technology, while promising, requires a paradigm shift and better integration into health systems to avoid being just a "panacea."

DISCUSSION

The results of this systematic review indicate that smart oximeters significantly improve the management of COPD.

The ability to detect early decreases in SpO_2 and predict exacerbations was a central finding, with digital systems demonstrating the ability to identify physiological changes days before the event, allowing for rapid interventions.[8,10] The decrease in hospitalizations was a robust outcome, with studies reporting reductions of 25% to 30% in hospitalization rates or readmissions,[6,9] relieving pressure on health systems and reducing costs.[2,5] Improvement in quality of life (assessed by instruments such as the CAT) was also observed,[2,4,5] suggesting greater control and well-being for patients.

Early detection of exacerbations is critical, as these events increase morbidity and mortality. Remote monitoring promotes proactive care, in line with guidelines such as those in GOLD (2024).[3] The reduction in hospitalizations optimizes resources, while the improvement in quality of life and high satisfaction (reaching 90% in 1 study) reflect good acceptance of the devices by patients.

The implications of these findings suggest that the adoption of smart oximeters can transform COPD care, leading to more proactive management, reduction of healthcare costs associated with exacerbations and hospitalizations, and substantial improvement in patient well-being and autonomy.

However, limitations include technological barriers, such as internet access and digital proficiency, especially in the elderly. The integration of data in electronic medical records and data security require attention, as pointed out by studies on the implementation of new digital technologies.[7]

Future studies should include larger RCTs, with prolonged follow-up, and cost-effectiveness analyses.

CONCLUSION

Smart oximeters have demonstrated significant potential to optimize COPD management by reducing exacerbations, hospitalizations, and improving quality of life. Overcoming technological barriers and standardizing protocols are essential for its large-scale adoption. Future research should focus on robust clinical trials and implementation strategies to maximize the clinical and economic benefits of this technology, aiming to better integrate these devices into clinical practice and health policies.

Authors' contributions

Gabriel Mathias Vitoreti: Conceptualization
Homero Grein Neto: Methodology
Mariana Tiboni Nacamura: Writing (original draft)
Luiz Eduardo Latorre Guimarães: Writing (proofreading and editing):

REFERENCES

1. Ambrosino N, Vitacca M, Dreher M, Isetta V, Montserrat JM, Tonia T, et al. Telemonitoramento de pacientes dependentes de ventilador: uma declaração da Sociedade Respiratória Europeia. Eur Respir J. 2016;48(3):648-63. https://doi.org/10.1183/13993003.01721-2015
2. Aranburu-Imatz A, Arbillaga-Etxarri A, Gorostiza A, Altube L, Ugarte U, Mujika A, et al. Nurse-led interventions in chronic obstructive pulmonary disease patients: a systematic review and meta-analysis. Int J Environ Res Public Health. 2022;19(15):9101. https://doi.org/10.3390/ijerph19159101
3. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Estratégia global para o diagnóstico, manejo e prevenção da doença pulmonar obstrutiva crônica. 2024. Disponível em: https://goldcopd.org/
4. Hardinge M, Rutter H, Velardo C, Shah SA, Williams V, Tarassenko L, et al. Using a mobile health application to support self-management in chronic obstructive pulmonary disease: a six-month cohort study. BMC Med Inform Decis Mak. 2015;15:46. https://doi.org/10.1186/s12911-015-0161-7
5. Ho TW, Huang CT, Chiu HC, Ruan SY, Tsai YJ, Yu CJ. Effectiveness of telemonitoring in patients with chronic obstructive pulmonary disease in Taiwan—a randomized controlled trial. Sci Rep. 2016;6:23797. https://doi.org/10.1038/srep23797
6. McDowell JE, McClean S, FitzGibbon F, Tate S, Taylor M, O'Neill H, et al. A randomised clinical trial of the effectiveness of home-based health care with telemonitoring in patients with COPD. J Telemed Telecare. 2015;21(2):80-7. https://doi.org/10.1177/1357633X14566575
7. Pinnock H, McKinstry B. Tecnologia digital em doenças respiratórias: promessas, (nenhuma) panaceia e hora de um novo paradigma. Chron Respir Dis. 2016;13(2):189-91. https://doi.org/10.1177/1479972316637788
8. Sanchez-Morillo D, Fernandez-Granero MA, Leon-Jimenez A. Use of predictive algorithms in-home monitoring of chronic obstructive pulmonary disease and asthma: a systematic review. Chron Respir Dis. 2016;13(3):264-83.
9. Segrelles-Calvo D, Gómez-Sánchez D, Soriano JB, Zamora E, Cortell-Aznar I, Molina-París J, et al. Programa de teleassistência domiciliar para pacientes com DPOC grave: estudo PROMETE. Respir Med. 2015;109(3):342-7. https://doi.org/10.36416/1806-3756/e20220067
10. Shah SA, Velardo C, Farmer A, Tarassenko L. Exacerbations in chronic obstructive pulmonary disease: identification and prediction using a digital health system. J Med Internet Res. 2017;19(3):e69. https://doi.org/10.2196/jmir.7207