Hyperbaric oxygen therapy in clinical practice in wounds

Oxigenioterapia hiperbárica na prática clínica em feridas

La oxigenoterapia hiperbárica en la práctica clínica en heridas

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REVISA

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RESUMO

Objetivo: descrever o conhecimento dos profissionais de enfermagem sobre a oxigenoterapia hiperbárica na prática clínica. **Método:** Trata-se de uma revisão integrativa, realizada no mês de setembro de 2024. A busca foi feita através do Portal de Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) e da Biblioteca Virtual de Saúde (BVS), que abrangem as principais bases de dados e suas publicações acerca dos temas relacionados à saúde. Foram encontrados 14 artigos na plataforma CAPES, e 78 na BVS, totalizando 92 artigos, e após a análise seguindo as instruções fundamentais da Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA), foram incluídos oito artigos na revisão, publicados na National Library of Medicine National Institutes of Health (PubMed) e Scientific Eletronic Library Online (SciElo). **Resultados:** Foram incluídos neste estudo oito artigos que versam sobre o conhecimento sobre a oxigenoterapia hiperbárica na prática clínica de feridas. **Conclusão:** Constatou-se na presente revisão, que a OHB apresentou resultados clínicos favoráveis como terapia adjuvante no tratamento de lesões complexas diversas, como na melhora da cicatrização na ferida, mostrando o papel do enfermeiro e sua praxis no cuidado às pessoas com lesão de pele.

Descritores: Oxigenioterapia hiperbárica; Feridas; enfermeira; prática clínica baseada em evidências; Cicatrização.

ABSTRACT

Objective: to describe the knowledge of nursing professionals about hyperbaric oxygen therapy in clinical practice. **Method:** This is an integrative review, carried out in September 2024. The search was carried out through the Periodicals Portal of the Coordination for the Improvement of Higher Education Personnel (CAPES) and the Virtual Health Library (VHL), which cover the main databases and their publications on health-related topics. 14 articles were found on the CAPES platform, and 78 on the VHL, totaling 92 articles, and after analysis following the fundamental instructions of the Preferred Reporting Items for Systematic Reviews and Meta Analyzes (PRISMA), eight articles were included in the review, published in the National Library of Medicine National Institutes of Health (PubMed) and Scientific Electronic Library Online (SciElo). **Results:** Eight articles were included in this study that deal with knowledge about hyperbaric oxygen therapy in clinical wound practice. **Conclusion:** In this review, it was found that HBOT presented favorable clinical results as an adjuvant therapy in the treatment of various complex injuries, such as improving wound healing, showing the role of nurses and their practice in caring for people with skin injuries.

Descriptors: Hyperbaric oxygen therapy; Wounds; nurse; evidence-based clinical practice; Healing.

RESUMEN

Objetivo: describir el conocimiento de los profesionales de enfermería sobre la oxigenoterapia hiperbárica en la práctica clínica. **Método:** Se trata de una revisión integradora, realizada en septiembre de 2024. La búsqueda se realizó a través del Portal de Revistas de la Coordinación de Perfeccionamiento del Personal de Educación Superior (CAPES) y la Biblioteca Virtual en Salud (BVS), que cubren las principales bases de datos y sus publicaciones sobre temas relacionados con la salud. Se encontraron 14 artículos en la plataforma CAPES y 78 en la BVS, totalizando 92 artículos, y luego del análisis siguiendo las instrucciones fundamentales del Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA), se incluyeron en la revisión diez artículos, publicados. en la Biblioteca Nacional de Medicina, Institutos Nacionales de Salud (PubMed) y Biblioteca Electrónica Científica en Línea (SciElo). **Resultados:** En este estudio se incluyeron ocho artículos que abordan el conocimiento sobre la oxigenoterapia hiperbárica en la práctica clínica de heridas. **Conclusión:** En esta revisión, se encontró que TOHB presentó resultados clínicos favorables como terapia coadyuvante en el tratamiento de diversas lesiones complejas, como la mejora de la cicatrización de heridas, mostrando el papel del enfermero y su práctica en el cuidado de personas con lesiones en la piel.

Descriptores: Oxígenoterapia hiperbárica; Heridas; enfermero; práctica clínica basada en evidência; Cicatrización.

Introduction

Considering hyperbaric oxygen therapy (HBOT) as an adjuvant therapy that accelerates the healing process of complex wounds, it is urgent to understand the scientific evidence focused on the clinical practice of nurses to accelerate the wound healing process and reduce expenses with public coffers and improve the quality of life of people and their families[1].

HBOT is a therapeutic modality that uses 100% pure oxygen in a pressurized chamber with an atmospheric pressure up to 2 times higher, showing promise in clinical conditions and especially in complex wounds such as diabetic ulcers, venous ulcers, pressure injuries, burns, among others, being used concomitantly with topical therapies or not, improving the healing process[2].

Epidemiological studies indicate that the incidence of complex wounds has grown, especially in populations with comorbidities such as diabetes and hypertension. In the UK, diabetic foot patients account for a prevalence of 25%, venous ulcers for 1% to 2% of the general population, and pressure ulcers have prevalence data of 6% to 10% in hospitals, and all these injuries can benefit from HBOT[3]. In Brazil, these data tend to be higher, with an estimated 5 million Brazilians suffering from complex wounds, a serious public health problem in the country. The adoption of HBOT as an additional therapeutic approach has shown positive results in accelerating the healing process, with a growing demand for this treatment in the Unified Health System (SUS)[4].

However, the costs associated with HBOT are significant, representing a challenge for the public health system. An international study conducted in the United States of America revealed a cost of US$ 595.86 per session, with different indications, the estimated costs ranged from US$ 2,383.4 to US$ 8,342.04 for crush injuries to US$ 17,875.80 to US$ 35,751.60 for diabetic foot ulcers and late radiation injuries4. In Brazil, this cost varies from R$ 400.00 to R$ 1000.00 per session, regardless of the etiology5. It is observed that the economic viability of this type of therapy is high, since it involves advanced technology and specialized professionals.[1]

The epidemiological magnitude of the wounds in the population, added to the scarcity of studies focused on the experience of these patients during HBOT treatment, raised the following question: What is the knowledge of nursing professionals about hyperbaric oxygen therapy in clinical practice? The objective of this study is to describe the knowledge of nursing professionals about hyperbaric oxygen therapy in clinical practice. Thus, studying this relationship between nursing professionals' knowledge about hyperbaric oxygen therapy will increase the understanding of how this adjuvant therapy can transform the lives of these people, contributing significantly to clinical nursing practice.

The epidemiological magnitude of the wounds in the population, added to the scarcity of studies focused on the experience of these patients during HBOT treatment, raised the following question: What is the knowledge of nursing professionals about hyperbaric oxygen therapy in clinical practice? The objective of this study is to describe the knowledge of nursing professionals about hyperbaric oxygen therapy in clinical practice.

Thus, studying this relationship between nursing professionals' knowledge about hyperbaric oxygen therapy will increase the understanding of

how this adjuvant therapy can transform the lives of these people, contributing significantly to clinical nursing practice.

Method

It is an integrative literature review, which allows the identification of publications on a given topic, through the collection, organization and analysis of studies, evidencing results that aim to guide better clinical practice. Integrative reviews aim to present strategies that support better performance in health care and enable the identification of scientific gaps within the theme and the needs that future research needs to explore. The review was developed in six stages, which will be detailed below:

In the first stage, which refers to the elaboration of the guiding question, the acronym PCC - Population (P), Concept (C) and Context (C) (Chart 1) was used, which resulted in the following question: What is the knowledge of nurses about hyperbaric oxygen therapy in the context of evidence-based clinical practice?

Table 1 - Implementation of the CCP strategy

Acrônimo	Definition	Aplication
P	Population	Nurses
C	Concept	Hyperbaric oxygen therapy for healing
C	Context	Evidence-based clinical practice

As for the second stage, search or sampling in the literature, it was carried out during the month of September 2024, using the following search strategy: (Nurs* AND Hyperbaric Oxygenation) AND ("Evidence-Based Practice") AND (Wound Healing) established from the Health Sciences Descriptors (DECS): "Nursing team", "Hyperbaric oxygen therapy" and "evidence-based clinical practice" and healing considering their respective translations into English. The search was carried out through CAPES and the VHL, which cover the main databases and their publications on health-related topics, allowing the diversity of the articles that were found.

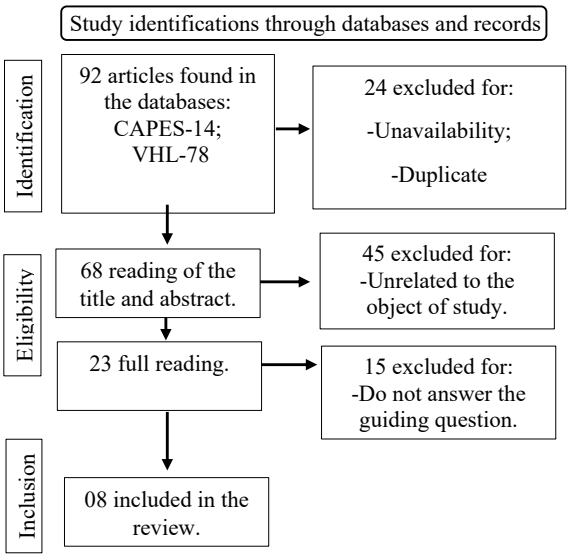
Original, complete, free articles published between 1995 and 2024 were included. It is noteworthy that the time frame chosen reflects the year in which hyperbaric oxygen therapy had its procedures regulated in Brazil as a therapeutic modality through Resolution 1.457/95 of the Federal Council of Medicine1, involving nursing professionals and other areas of multidisciplinary health. Duplicate articles in the databases and those that did not meet the objective of this integrative review were excluded.

Initially, 14 articles were found in the CAPES platform and 78 in the VHL, totaling 92 articles. The results were sent to the Mendeley academic software, a platform used to manage storage and verify the duplicity of studies.

The screening of studies was carried out by two reviewers, independently, applying the inclusion and exclusion criteria. 15 studies that were unavailable for free and in full, and 9 articles were excluded because they were duplicates. Subsequently, the titles and abstracts of the remaining 68

studies were read, and it was found that 45 were not related to the object of the study. After that, 23 articles were read in full. Of these, 15 did not answer the guiding question or did not make clear the knowledge of nurses about hyperbaric oxygen therapy in the context of evidence-based clinical practice, leaving 08 articles included in this review.

The fundamental instructions for reviews of the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) were used, regarding the identification, eligibility and inclusion of studies, as shown in Figure 2.



In the third stage, for data extraction, a synoptic table was prepared to organize the data that made up the analytical corpus, composed of information such as identification/year, title, method, objectives, results, and level of evidence.

The fourth stage, which corresponds to the evaluation of the included studies, was carried out according to the categorization of the Agency for Healthcare Research and Quality (AHRQ), which classifies the levels of evidence of the studies as: Level 1 - meta-analysis of multiple controlled studies; Level 2 - individual studies with an experimental design; Level 3 - studies with a quasi-experimental design; Level 4 - studies with a non-experimental design, such as descriptive or qualitative studies; Level 5 - case reports/experiences; Level 6- opinions or interpretation of information by experts[7].

Regarding the fifth stage, which corresponds to the interpretation of the results, they were discussed based on the national and international scientific literature. The sixth and final step, presentation of the review, is discussed below, with all the evidence and the main results found in this review.

Results

Eight articles were included in this study that deal with knowledge about hyperbaric oxygen therapy in clinical wound practice. Although the VHL and CAPES cover more than five databases, the results of this review were found in only two of them: the National Library of Medicine, National Institutes of Health (PubMed) and the Scientific Electronic Library Online (SciElo). To facilitate discussion of the results, the included studies will be identified by a sequential unit: E1, E2, E3, and so on, followed by the number.

Chart 3 – Articles selected for this review.

Id./ Year	Title/Country	Method	Objectives	Results	Evidence Level
E1[8] 2023	Topical Wound Oxygen Therapy in the Treatment of Severe Diabetic Foot Ulcers: A Prospective Controlled Study	Prospective controlled study	To evaluate the efficacy and safety of HBOT as an adjunctive therapy to conventional multidisciplinary treatment (CMT) of diabetic foot, compared to CMT without HBOT	This guideline contains seven evidence-based recommendations and 30 good clinical practice (GCP) recommendations. Evidence-based recommendations are given in favor of hyperbaric oxygenation	Level 2
E2[9] 2021	Efficacy of Hyperbaric Oxygen Therapy for Diabetic Foot Ulcer, A Systematic Review and Meta-Analysis of Controlled Clinical Trials	Meta-analysis of randomized controlled trials	To assess whether hyperbaric oxygen (HBOT) therapy is effective in healing diabetic foot ulcers (UPD)	This meta-analysis concludes that HBOT was associated with higher rates of completely healed wounds and lower amputation rates	Level 1
E3[10] 2020	Hyperbaric oxygen therapy as an adjuvant treatment for wounds: a prevalence study	Cross-sectional, quantitative and retrospective study	To describe the prevalence of wound types indicated for hyperbaric oxygen therapy	The prevalence was between 19-49 years and 61-72 years (both 27.1%), male gender (68.3%), diabetes mellitus (44.1%) and surgical dehiscence (20.3%). People aged 61-72 years had longer session times (median = 40 sessions).	Level 2
E4[11] 2014	Evaluation of hyperbaric oxygen therapy for chronic wounds	Retrospective study	Describe the effectiveness of HBOT in the treatment of chronic wounds due to a variety of causes in our institution	HBOT is an effective treatment for patients with chronic wounds. However, HBOT is less effective in patients with DM than in patients with venous stasis	Level 2
E5[12] 2010	Legal issues in Brazilian hyperbaric nursing: why regulate?	Synthesis of evidence on hyperbaric oxygen therapy	To point out the need to standardize nursing care related to hyperbaric oxygenation and to regulate the working conditions for the nursing team that works in this area.	It allowed us to reflect on the dissemination of the state of the art of hyperbaric nursing, as well as the incorporation of this activity in the list of specialties contained in COFEN Resolution 290/2004 and graduate courses in Nursing.	Level 8

E6[13] 2023	Indication of hyperbaric oxygen therapy as an aid in the healing of lower limb ulcers	Case Study	Describe hyperbaric oxygen therapy, as well as clarify its indications and limitations.	Benefits of HBOT in diabetic ulcers, however, in the case of stasis ulcers, the reduction in the size of the lesions is not sustainable over time	Level 5
E7[14] 2019	Praxis of the nurse and hyperbaric nursing team in the care of people with skin lesions	Original, qualitative research	Contextualize the praxis of nurses and hyperbaric nursing staff in the care of people with skin lesions	The practice of the nurse/Hyperbaric Nursing team took place in different work processes: preparing the therapeutic environment and the person with skin lesions for the application of the therapy, ensuring safety and comfort during the procedures performed, monitoring the hyperbaric session, ensuring compliance with it, preventing complications and ensuring general stability at the end of the hyperbaric session.	Level 4
E8[15] 2017	Adjuvant Hyperbaric Oxygen Therapy for Cure of Chronic Diabetic Foot Ulcers: A Randomized Clinical Trial.	Prospective controlled study	To compare the effect of standard wound care with adjunctive hyperbaric oxygen therapy (HBOT) to standard wound care alone on wound healing, markers of inflammation, glycemic control, amputation rate, tissue survival rate, and health-related factors	Study shows that adjuvant HBOT improved wound healing in diabetic people. The therapy also reduced the risk of amputation of the affected limb	Level 2

Discussion

Study shows seven evidence-based recommendations and 30 good clinical practice (GCP) recommendations. Evidence-based recommendations are given in favor of hydrogel, hyperbaric oxygenation[8]. The nurse must have technical preparation and experience to provide differentiated care to the patient undergoing HBOT, monitoring and observing the performance of the procedure, identifying possible side effects and acting effectively if they arise[16].

A evidência de que a terapia de oxigênio hiperbárico é eficaz como uma medida de tratamento adjunto para úlceras do pé diabético. Estudos que avaliaram o efeito da OHB na úlcera do pé diabético, cura completa,

amputação, eventos adversos, área de redução da úlcera e taxa de mortalidade[9]. From 1984 study records examined, results with pooled analysis showed that HBOT was significantly effective in complete healing of diabetic foot ulcer and reducing major amputation. Although it was not effective for minor amputations, fewer adverse events were reported in the standard care group. However, the reduction in the mean percentage of ulcer area and mortality rate did not differ in the HBOT and control groups[9]. Another study found that adjuvant HBOT improved wound healing in people with diabetes. The therapy also reduced the risk of amputation of the affected limb[15]. We state that it takes at least 20 sessions of HBOT to be effective. HBOT showed statistically significant improvements in inflammation index, blood flow, and health-related quality of life from pre-treatment to 2 weeks after the end of the last therapy[15]. This is corroborated by a national study that shows significant reductions in amputation rates, in addition to the high rate of partial tissue reconstitution and total healing of the chronic wound in diabetic foot[17]

In addition to pathology such as diabetes mellitus, the study reveals that in the 60 medical records analyzed, the following were prevalent: age between 19-49 years and 61-72 years (both with 27.1%), male gender (68.3%), Diabetes Mellitus (44.1%) and surgical dehiscence (20.3%). People aged 61-72 years had longer session time (median = 40 sessions)[10]. Regarding lifestyle habits, smoking was more widely distributed (73.3%). The diseases associated with the indications for HBOT were Diabetes Mellitus (DM) (44.1%), Systemic Arterial Hypertension (SAH) (37.3%) and Neoplasms (6.8%) and as for wounds with indication for HBOT, the following were observed: surgical dehiscence (20.3%), followed by diabetic foot lesions (16.9%), osteomyelitis (13.6%), pressure injuries (PPL) (10.2%) and venous ulcer (8.5%)[10]. The variable others had a representative distribution (25.4%) and this refers to the indication of HBOT for wounds that were not included in the data collection instrument, such as gangrene, abscesses and decompressive fasciotomy secondary to compartment syndrome[10]. When performing the statistical regression test by automatic linear modeling using the variable treatment time (sessions) for the disease as a predictor, we observed that people who have chemical dependence on nicotine ($P=0.011$), followed by hematological disease ($p<0.05$) are the predictors with statistical significance[10]. However, a study reveals that HBOT does not improve the prognosis of stasis ulcers, according to the Cochrane systematic review of 2015[13]. In stasis ulcers, HBOT can reduce the area of the lesions, but this benefit is not sustained in the medium and long term. Thus, according to robust and current evidence, HBOT is not indicated for the treatment of stasis ulcers, when its use is restricted to more severe cases with deep tissue involvement or bone exposure[13].

Regarding the time spent diving in the hyperbaric chamber, a study reveals the results of patients undergoing hyperbaric oxygen therapy for 60 minutes with 100% oxygen administered by mask in a hyperbaric chamber pressurized at 2.8 atmospheres of absolute pressure11. The response of chronic wounds to HBOT was evaluated according to the following criteria: "excellent": more than 90% wound healing; "Good": a greater than 30% reduction in wound size, and wound healing was confirmed at follow-up visits within 6 weeks; "reasonable": wound healing was achieved with a combination of other invasive interventions; and "poor": the wound showed a reduction of less than 30% or worsened during HBOT, or wound healing was not completed at follow-up

visits within 6 weeks[11]. The response to HBOT was "excellent" in 6 patients, "good" in 8, "fair" in 11, and "poor" in 4. All 4 patients with a "poor" response had DM and underwent hemodialysis. HBOT is an effective treatment for patients with chronic wounds, due to a variety of causes, when used in combination with conventional standard therapy or additional interventions[11].

A study shows that hyperbaric nursing care is provided from the patient's arrival at the service for treatment until their departure. Therefore, they can be classified as: Pre-HBOT, which is the care provided to the patient before entering the hyperbaric chamber for effective treatment, trans-HBOT, which refers to the care provided to the patient during the entire treatment session, that is, from the moment pressurization began until the end of depressurization, and post-HBOT, which refers to the care provided to the patient immediately after the treatment session until the patient's departure from the institution[12]. The role of the hyperbaric nursing professional comprises, as a rule, guidance to the client on diving safety measures, monitoring and observation during HBOT treatment, compliance with treatment tables, such as: TPD (Standard Decompression Table) TDSO (Decompression Table with the Use of Oxygen) TLSD (Table without Decompression Limit), observation of the side effects of HBOT, as well as provision of basic life support in case of accidents, seizures or pulmonary or neurological intoxication. As long as you are enabled to operate the control panel, you can act as an operator of both single-seat and multi-place cameras[18].

Nursing care in the pre-OTHB phase aims to prepare the therapeutic environment and the patient to ensure safety and comfort during treatment. The internal guide (IG) is responsible for keeping the hyperbaric chamber environment clean and organized, checking the operation of the equipment and ensuring that patients wear safe clothing. He also performs special care with invasive materials, accommodates patients inside the chamber, and checks their general medical status, reporting abnormalities to the doctor. The external guide (EG) guides patients on the proper use of the OTHB mask, ensuring that it is well-fitting to prevent oxygen leaks. He also teaches pressure equalization maneuvers to prevent barotraumas and helps accommodate patients with mobility difficulties[19]. Trans hyperbaric oxygen therapy nursing care is care performed during therapy with the objective of enabling the patient's adaptation to the hyperbaric environment, allowing compliance with the protocoled treatment[19]. Nursing Care after hyperbaric oxygen therapy aims to ensure complete patient care and stability until leaving the service. The Immersion Group (IG) must collect and organize the equipment, check that there are no forgotten personal objects, inform the guide of the next session about technical problems and help the Nursing Group (EG) in the management of patients with difficulties. The EG is responsible for assisting patients in leaving the chamber, checking vital signs when necessary, attending to patient requests, and assisting with transportation to vehicles, if necessary[19].

Another study analyzes the praxis of nurses and the hyperbaric nursing team in the care of people with skin lesions, which resulted in different work processes: preparing the therapeutic environment and the person with skin lesions for the application of the therapy, ensuring safety and comfort during the procedures performed, monitoring the hyperbaric session, ensure compliance with it, prevent complications and ensure general stability at the end of the hyperbaric session; being a field of action and a therapeutic resource

for Dermatological Nursing with great potential for improvement for skin lesions[14]. According to the SBMH, the nursing professional must have training in hyperbaric medicine in some of the courses recognized by the SBHM, and must select and train the nursing team, nursing technicians can only perform their activities under the guidance and supervision of the nurse according to federal law n° 7.498/86[20].

Conclusion

In the present review, it was found that HBOT presented favorable clinical results as an adjuvant therapy in the treatment of various complex lesions, such as improving wound healing, showing the role of nurses and their praxis in the care of people with skin lesions.

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