Technologies in Pain Control for Cancer Patients: A Scoping Review

Tecnologias no Controle da Dor do Paciente com Câncer: Revisão de Escopo
Tecnologías para el Control del Dolor en Pacientes con Cáncer: Una Revisión Exploratoria

RESUMO
Introdução: A dor é uma das principais queixas do paciente com câncer. Mediante ao crescimento do número de casos de câncer, cada vez mais tecnologias vêm sendo aplicadas para aliviar o sofrimento do paciente. **Objetivo:** mapear na literatura as tecnologias disponíveis para o controle da dor dos pacientes com câncer. **Materiais e Método:** Trata-se de uma revisão de escopo, a partir do modelo do *Joanna Briggs Institute*. Para formulação da questão de pesquisa foi empregada a estratégia PCC (P: pacientes com câncer/ C: tecnologia em saúde/ C: controle da dor). A busca iniciou pelas Bases de dados: *Pubmed* e *LILACS*, ampliando após seleção de descritores e estudos para a demais bases de dados, incluindo o Google Acadêmico para literatura cinzenta. **Resultados:** Foram mapeados 1423 estudos, cumprindo-se as etapas de seleção, chegando a 9 estudos para análise qualitativa. As Tecnologias foram categorizadas em: Medicamentos, Equipamentos médicos e Terapias alternativas. Os medicamentos encontrados foram: a Hidromorfona, a Buprenorfina Transdérmica, o Remifentanil e as Coberturas Tópicas. Para os Equipamentos médicos, destaca-se o uso da Bomba de Infusão Intratecal. E para Terapias Alternativas: a Acupressão/ acupuntura e a técnica de Imposição das Mãos. **Conclusão:** As tecnologias relacionadas às medicações seguiram a linha de tratamento para dor moderada a severa, com uso de opióides. Já as coberturas tópicas acrescentaram os anestésicos e antibióticos locais. Já as bombas de intratecais apresentam indicação para dor de difícil manejo, com doses mais precisas. E terapias alternativas auxiliam no controle da dor, tanto de forma isolada ou associadas a tratamentos.
DESCRITORES: Câncer. Dor. Avaliação da tecnologia biomédica. Analgesia. Dor Associada a Câncer.

ABSTRACT
Introduction: Pain is one of the main complaints of cancer patients. Given the increase in the number of cancer cases, more and more technologies have been applied to alleviate patient suffering. **Objective:** to map the available technologies for pain control in cancer patients in the literature. **Materials and Method:** This is a scoping review based on the Joanna Briggs Institute model. The PCC strategy was used to formulate the research question (P: cancer patients/C: health technology/C: pain control). The search began in the Pubmed and LILACS databases, expanding after selecting descriptors and studies to other databases, including Google Scholar for gray literature. **Results:** 1,423 studies were mapped, complying with the selection steps, reaching 9 studies for qualitative analysis. The technologies were categorized as: Medicines, Medical equipment and Alternative therapies. The medications found were: Hydromorphone, Transdermal Buprenorphine, Remifentanil and Topical Coverings. For medical equipment, the use of the Intrathecal Infusion Pump stands out. And for Alternative Therapies: Acupressure/acupuncture and the Laying on of Hands technique.
Conclusion: The technologies related to medications followed the treatment line for moderate to severe pain, with the use of opioids. Topical coverings added local anesthetics and antibiotics. Intrathecal pumps are indicated for difficult-to-manage pain, with more precise doses. And alternative therapies help control pain, either alone or in combination with treatments.
DESCRIPTORS: Cancer. Pain. Biomedical technology assessment. Analgesia. Cancer-associated pain.

RESUMEN
Introducción: El dolor es una de las principales quejas de los pacientes con cáncer. A medida que aumenta el número de casos de cáncer, se aplican cada vez más tecnologías para aliviar el sufrimiento de los pacientes. **Objetivo:** mapear en la literatura las tecnologías disponibles para el control del dolor en

DOI: 10.36489/saudecoletiva.2025v15i97p16106-16125

pacientes con cáncer. **Materiales y Métodos:** Se trata de una revisión de alcance, basada en el modelo del Instituto Joanna Briggs. Se utilizó la estrategia PCC para formular la pregunta de investigación (P: pacientes con cáncer/ C: tecnología sanitaria/ C: control del dolor). La búsqueda se inició con las bases de datos: Pubmed y LILACS, ampliándose luego de la selección de descriptores y estudios a otras bases de datos, incluyendo Google Scholar para literatura gris. **Resultados:** Se mapearon 1423 estudios, completando las etapas de selección, resultando 9 estudios para análisis cualitativo. Las tecnologías se categorizaron en: Medicamentos, Equipos médicos y Terapias alternativas. Los medicamentos encontrados fueron: Hidromorfona, Buprenorfina Transdérmica, Remifentanilo y Coberturas Tópicas. Para los equipos médicos se destaca el uso de la Bomba de Infusión Intratecal. Y para Terapias Alternativas: Acupresión/acupuntura y la técnica de Imposición de Manos. **Conclusión:** Las tecnologías relacionadas con medicamentos siguieron la línea de tratamiento del dolor moderado a severo, con el uso de opioides. Los apósitos tópicos agregan anestésicos locales y antibióticos. Las bombas intratecales están indicadas en casos de dolor de difícil manejo, con dosis más precisas. Y las terapias alternativas ayudan a controlar el dolor, ya sea solas o en combinación con tratamientos.

DESCRIPTORES: Cáncer. Dolor. Evaluación de tecnología biomédica. Analgesia. Dolor asociado con el cáncer.

RECEIVED: 05/27/2025 **APPROVED:** 06/13/2025

How to cite this article: Soares RS, Cunha DAO, Lima VCGS, Fuly PSC. Technologies in Pain Control for Cancer Patients: A Scoping Review. Saúde Coletiva (Edição Brasileira) [Internet]. 2025 [acesso ano mês dia];15(97):16106-16125. Disponível em: DOI: 10.36489/saudecoletiva.2025v15i97p16106-16125

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INTRODUCTION

Cancer is the second leading cause of death worldwide, with 9.6 million deaths recorded in 2018. In the Americas, it was responsible for 45% of deaths in all of Latin America and the Caribbean, with an expected increase of 2.1 million deaths by 2030. In Brazil, 704,000 new cases of cancer are expected each year in the three-year period 2023/2025.[1-2]

Among cancer patients, one of the main complaints is pain, which can be caused by the disease itself or by treatment. It is estimated that 55% of patients undergoing antineoplastic treatment have pain, 39.3% feel pain after treatment, and this figure rises to 66.4% in advanced, metastatic or terminal disease. And when it comes to pain intensity, 38% of patients complain of moderate to severe pain. Therefore, it is always necessary to innovate treatments in order to alleviate suffering and provide comfort to the patient.[3-4]

From this perspective, health technology has collaborated with innovations in the treatment of both cancer patients and patients with other morbidities. Health technology is the application of organized knowledge and skills such as devices, medicines, vaccines, procedures and systems that aim to improve quality of life. Therefore, disseminating knowledge about new technologies is important so that health professionals can improve their clinical practice. The aim of this review was therefore to map the technologies available in the literature for controlling pain in cancer patients. [5]

A preliminary search was carried out on the PROSPERO and Open Science Framework (OSF) databases with the

following combination of descriptors: pain and cancer and analgesic, Technology Assessment, Biomedical and no similar protocols were found.

METHOD

This is a scoping review based on the Joanna Briggs Institute (JBI) model, in accordance with the JBI Scoping Review Manual, and the article was constructed in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews PRISMA-SCR checklist, which is specific to the construction of scoping reviews. 6,7The study protocol has been published on the Open Science Framework (OSF) and is available at: https://osf.io/ezm5a.

To formulate the research question, the PCC strategy was used (Population: cancer patients/ Concept: health technology/ Context: pain control), in line with the JBI guidelines for scoping, which generated the research question: What health technologies can be applied to pain control in cancer patients? No restrictions as to year or language of publication were used in the search strategy. [6-7]

The search for descriptors was based on an analysis of research published in the National Library of Medicine (Pubmed) and Latin American and Caribbean Health Sciences (LILACS) databases: National Library of Medicine (Pubmed) and Latin American and Caribbean Literature in Health Sciences (LILACS). The descriptors indexed by the Medical Subject Heading Terms (MeSH) were: pain, cancer, neoplasm, analgesic, technology assessment biomedical. And the Health Sciences Descriptors (DeCS) indexed were: Pain, Cancer and Biomedical Assessment.

In the second stage, the descriptors were combined and expanded to include 7 more databases, bringing the total to 9. For gray literature, a search was carried out on Google Scholar. As shown in the table:

Chart 1 - Combination of descriptors to search for studies. Rio de Janeiro, RJ, Brazil, 2024.

Portal	Databases	Combination of descriptors
VHL-Virtual Health Library	MEDLINE (*Medical Literature Analysis and Retrievel System Online*)	Biomedical technology assessment AND cancer AND pain
	BRISA/RedTESA (*Base Regional de Informes de Avaliação de Tecnologias em Saúde das Américas*)	
	LILACS (*Literatura Latino-Americano e do Caribe em Ciências da Saúde*)	
	BDENF (*Biblioteca Virtual de Enfermagem em Saúde*)	
CAPES (Coordination for the Improvement of Higher Education Personnel)	COCHRANE PUBMED	pain AND cancer AND analgesic AND Technology Assessment Biomedical
	SCOPUS EMBASE SCIENCE DIRECT	neoplasm OR cancer AND analgesics AND Technology Assessment, Biomedical
Gray literature	website	
	Google Scholar	pain AND biomedical technology AND neoplasms AND analgesia.

Source: Own authorship (2024).

Eligibility criteria

The studies were selected according to the following inclusion criteria: studies on technology, including analgesic treatments for cancer patients. The following were excluded: studies that did not address the objective of the study, editorials and incomplete studies.

Data collection

The literature search was carried out in April 2024. The data extraction phase involved two independent reviewers, who screened titles and abstracts for relevance. The Ryyan review software, developed by the Qatae Computing Research organization, was used to organize the titles and abstracts to be evaluated. The selection was made by two independent reviewers and any discrepancies were resolved by a third reviewer.

After this stage, the extracted data was organized into a collection tool, built using Excel software (Microsoft 365). For this research, the following information was extracted from the studies: study identification, title, author, objective, country, year, language, method, types of study, year of publication, Nature of health technology and Sample of technologies.

RESULTS

The search included 9 databases, and the gray literature was obtained from the Google Scholar website, reaching a total of 1,423 studies. The studies found for each database were: Medline (n=13), Cochrane (n=8), BRISA/REDTESA (n=9), PUBMED (n=20), LILACS (n=6), BDENF (n=2), EMBASE (n=49), in SCOPUS (n=23) and in SCIENCE DIRECT (n=273). And 1000 studies indexed in Google Scholar were found.

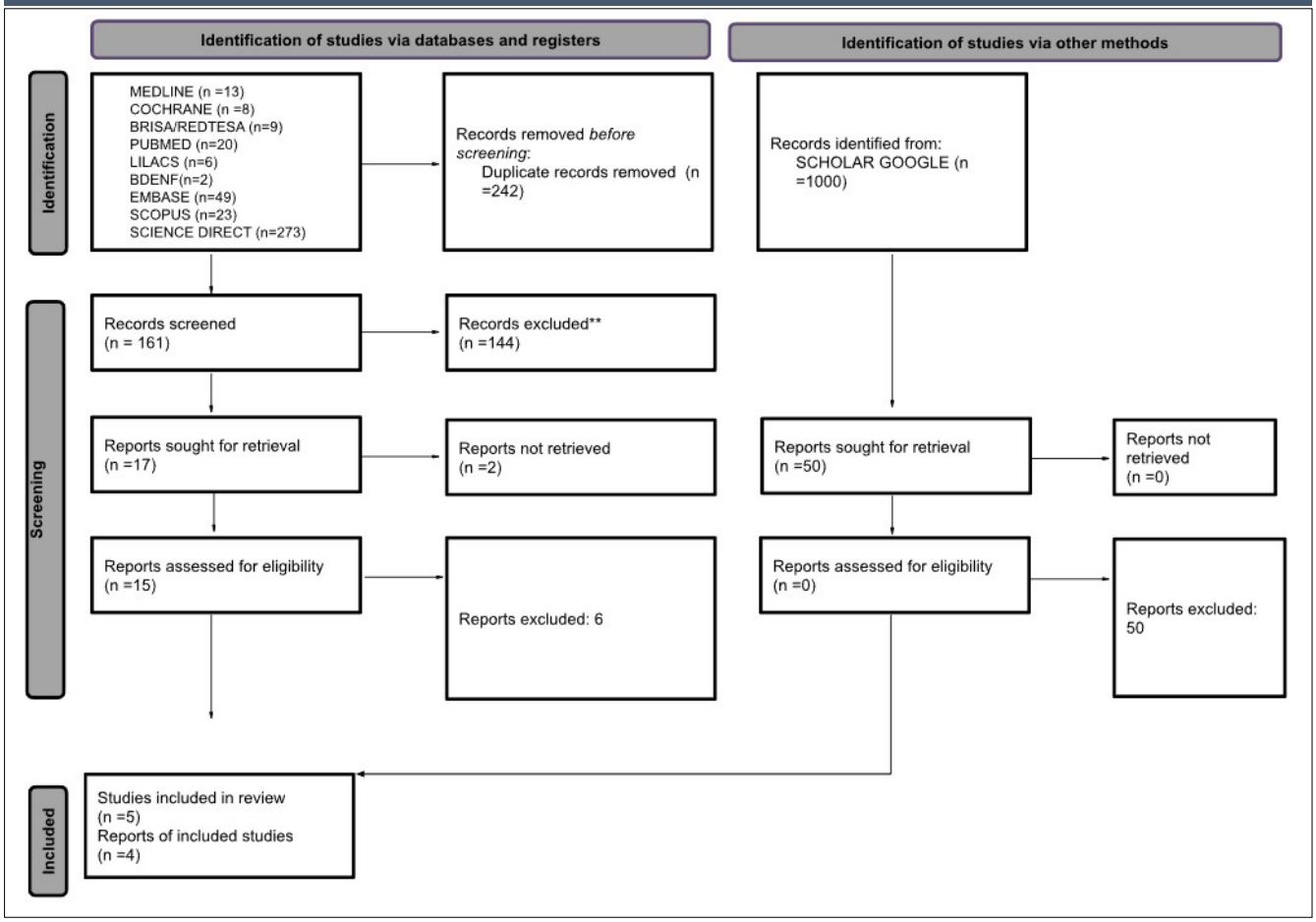
Of the total number of studies found, 242 were duplicates and were removed. In total, the reviewers went on to read the titles and abstracts. Af-

DOI: 10.36489/saudecoletiva.2025v15i97p16106-16125

ter the selection of the studies by the peers, the third reviewer resolved the disagreement, resulting in a total of 15 studies for evaluation of the criteria.

Of the 15 studies, 6 were excluded (5 did not answer the study question and 1 incomplete article). When reading the references, no other studies were included. The Prisma Flowchart is shown in Figure 1:

Figure 1 - Prisma SCR Flowchart. Rio de Janeiro, RJ, Brazil, 2024.



Source: PRISMA, 2020, Statement.

After analyzing 1,423 studies, only 9 studies were selected for qualitative analysis. The title, name of the main author, general objectives of the studies and country are shown in Table 2.

Chart 2 - Distribution of studies according to title, author, objective and country. Rio de Janeiro, RJ, Brazil, 2024 (n=9).

	TITLE	AUTHOR	OBJECTIVE	COUNTRY
E1	*Hydromorphone for cancer pain*[8]	Li Y et al.	To determine the analgesic efficacy of hydromorphone in relieving cancer pain, as well as the incidence and severity of any events	CHINA
E2	*Intrathecal opioid infusion pumps for chronic oncological and non-oncological pain*[9]	Rey-Ares, Lucila et al.	To evaluate the available evidence on the efficacy, safety and coverage policy aspects of intrathecal opioid infusion pumps for chronic cancer and non-cancer pain.	ARGENTINA

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E3	*Efficacy and safety of buprenorphine transdermal patch 35 mcg/h - 20mg in patients with moderate to severe chronic cancer pain who cannot tolerate other analgesic treatment by oral, intravenous or subcutaneous route.*[10]	Institute for Health Technology Evaluation and Research	To evaluate the efficacy and safety of buprenorphine transdermal therapy in patients with moderate to severe cancer pain	PERU
E4	*Intrathecal Drug Delivery Systems for Cancer Pain: A Health Technology Assessment.*[11]	Health Quality Ontario	To investigate the benefits, harms, cost-effectiveness and budgetary impact of intrathecal drug delivery systems compared to current standards of care for adult patients with chronic cancer pain.	CANA-DA
E5	*Effectiveness of topical treatment for pain control in malignant neoplastic hernia (MNH). Systematic review*[12]	Torres, Rincon.	To synthesize the available evidence on the efficacy of topical treatments for pain control in NMH.	COLOMBIA
E6	*Apllied nanotechonology for management of breakthrought cancer pain.*[13]	Sprintz M et al.	Describe the Remifentanil nanotechnology experiment for cancer pain control	USA
E7	*Intratecal pumps for giving opioids in chronic pain.*[14]	Williams JE et al.	To review the evidence on the use of intrathecal pump systems for opioid administration in patients with chronic pain, in order to draw conclusions on efficacy, side effects and ACE	USA
E8	*Clinical Evidence for Association of Acupuncture and Acupressure With Improved Cancer Pain: A Systematic Review and Meta-Analysis.*[15]	He Y et al.	To evaluate existing randomized clinical trials (RCTs) for evidence of the association of acupuncture and acupressure with the reduction of cancer pain.	CHINA
E9	*Application of the laying on of hands techniques in cancer, pain and stress-anxiety: a systematic review of the literature.*[16]	Motta, Pedro Mourão Roxo da	To systematically analyze the literature on the use and effect of Reiki, Therapeutic Touch and Healing Touch in cancer, pain and stress-anxiety care.	BRAZIL

Source: Own authorship (2024).

With regard to the languages of the studies found: English stood out with 5 publications (55%) , Portuguese with 1 publication (12%) and Spanish with 3 publications (33%). As for the methodology, the Systematic Review stood out with 6 publications (67%) and the other methods with only 1 publication each (11%). As for the types of study: 5 publications (55%) were scientific articles, 2

Chart 3 - Distribution of studies according to language, methodology, year of publication. Rio de Janeiro, RJ, Brazil, 2024.

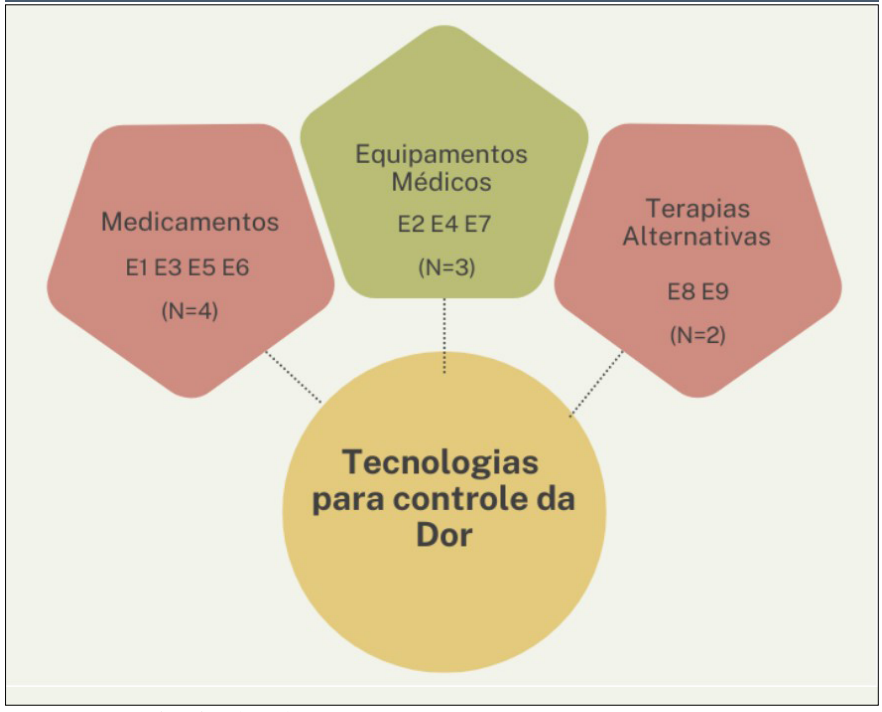
Study data		Number of studies selected (n- %)	Identification of studies
LANGUAGE	Spanish	3 (33%)	E2 E3 E5
	English	5(55%)	E1 E4 E6 E7 E8
	Portuguese	1 (12%)	E9
STUDY METHODOLOGY	Systematic review	6 (67%)	E1 E3 E5 E7 E8 E9
	Descriptive, experiment report	1(11%)	E6
	Cost-effectiveness analysis (ACE)	1 (11%)	E4
	Review	1(11%)	E2
TYPES OF STUDY	Thesis/Dissertation	*2(22,5%)*	E5 E9
	Technical documents	*2 (22,5%)*	E3 E4
	Scientific articles	*5 (55%)*	E1 E2 E6 E7 E8
	2011-2021	*7 (77%)*	E1 E2 E3 E4 E5 E8 E9
	2000-2010	*2 (23%)*	E6 E7

Source: Own authorship (2024)

DOI: 10.36489/saudecoletiva.2025v15i97p16106-16125

With regard to the nature of the health technologies found, publications on pain control medications stood out with 4 publications (44%), followed by 3 publications on medical equipment and, lastly, 2 publications on alternative therapies for pain control in cancer patients. As shown in Figure 2.

Figure 2 - Nature of Health Technologies. Rio de Janeiro, RJ, Brazil, 2024 (n=9).



Source: Own authorship (2024).

In the studies that dealt with related technologies, the medications found were: Hydromorphone, Transdermal Fentanyl, Transdermal Buprenorphine, Remifentanil and topical coverings for neoplastic wounds. With regard to medical equipment, the use of intrathecal infusion pumps for pain relief stands out. In this sense, intrathecal pumps stand out as the main technology used, accounting for 37.5% of the approaches. Other technologies appear with the same representation of 12.5% each: transdermal buprenorphine, remifentanil, topical coverings, reiki and acupuncture. This distribution highlights the diversity of strategies available, which include both pharmacological methods and complementary therapies, reflecting a multidisciplinary approach to cancer pain management.

DISCUSSION

Health technology aims to improve quality of life through treatments such as medications, devices and therapies. Thus, in the treatment of cancer and the control of symptoms, there has been an improvement over time, with the search for innovations to improve the patient's quality of life. [5, 17]

From this perspective, pain is considered one of the most prevalent symptoms in cancer patients. The prevalence of this symptom ranges from 48% during treatment to 55% in advanced cancer. In the review, we found technologies aimed at controlling pain in cancer patients that can be categorized according to their nature into: medications, medical equipment and alternative therapies as treatment modalities. [18-19]

Drug treatment for pain control in cancer patients is based on an assessment of the intensity of the patient's pain. According to the guidelines of the World Health Organization (WHO), when prescribing pain control medication, health professionals should follow the Ladder of Steps. In this guideline, the progression of medications follows 4 steps, starting with milder medications for pain considered to be weak, with the use of non-opioid analgesics (paracetamol and anti-inflammatories) up to invasive procedures for severe pain. According to the progression ladder, opioids are indicated for moderate to severe pain. [20-22]

In the studies, most of the pain control technologies related to medications follow this line of opioid treatment for moderate to severe pain. The medications related to this line of treatment were: Hydromorphone, Transdermal Buprenorphine and Remifentanil, as a nanotechnology prototype. [22, 8, 10, 12, 13]

Hydromorphone is a semi-synthetic derivative of morphine, which has advantages such as greater potency, absorption and solubility when compared to morphine and is already available for use in Brazil. It is the only opioid, administered in a single dose, with monophasic release, which promotes analgesia, depending on the dose, continuously during the 24-hour interval between doses. [21]

In this review, the action of hydromorphone was compared with morphine, oxycodone and fentanyl. In this study, there was no significant difference in action between the medications for pain control in cancer patients. However, in a double-blind randomized clinical trial comparing hydromorphone and morphine in the PCA pump (patient-controlled analgesia), a significant improvement in cancer patient pain was observed with

DOI: 10.36489/saudecoletiva.2025v15i97p16106-16125

hydromorphone. [8, 23]

The second drug technology described was Transdermal Buprenorphine. Buprenorphine is made from the opium derivative thebaine (poppy plant), considered an atypical opioid because it partially activates opiate receptors. It is considered to be a powerful analgesic that acts on the Central Nervous System. In transdermal form, it is released slowly over several days, providing more stable pain relief than analgesics that are administered intermittently. [10, 24-25]

In this review, the study pointed to the use of transdermal Buprenorphine for patients with stable pain, and it is considered a good option for patients with intolerance to oral medication. There is also evidence from Randomized Clinical Trials that Buprenorphine shows good results in reducing pain and improving the quality of life of cancer patients. [10, 26]

Another drug technology found was the Nanotechnology prototype composed of Remifentanil. Nanotechnology studies manipulate materials, structures and devices on the so-called nanoscale (1 to 100 nanometers). Increasingly, nanoscale devices are being evaluated to release drugs quickly and efficiently. [13, 27]

The study aims to develop a nanotechnological device for transmucosal drug release for the administration of Remifentanil in the treatment of disruptive cancer pain, emerging as a treatment option to the use of Oral Transmucosal Fentanyl Citrate (OTFC). Remifentanil is a synthetic opioid, widely used in anaesthetic practice, due to its rapid metabolization and short half-life. OTFC incorporates fentanyl citrate in tablets for absorption into the oral mucosa, and has already been used in the treatment of disruptive cancer pain. [13, 28]

The use of remifentanil as a prototype drug would show greater absorption, simple application and fewer side effects than traditional opioids. However, this is just one study and no evidence has yet been found of other research on human beings or applications in practice. [13]

And lastly, in the category of Medicines Technologies, there is the topical cover for local pain caused by Malignant Neoplastic Wound (MNW). A neoplastic wound is caused by a tumor growth that invades skin structures, breaking through the dermis and epidermis, causing pain due to the impairment of healthy structures and nerve endings. [29 ,3]

Thus, around 85% of patients with a neoplastic wound have pain directly in the tumor. To relieve the local pain caused by the tumor, topical analgesics (lidocaine cream with 5% prilocaine and topical morphine 0.2%) and the use of bactericides to control the infection and consequently relieve the local pain have been cited. [12]

There is a protocol in Brazil for the use of 2% lidocaine gel, which recommends applying it directly to the wound, covering the entire lesion and up to 2 cm of healthy tissue to control local pain. However, lidocaine gel with prilocaine is already a combination used as prior analgesia for debridement of chronic lesions and minor procedures. This topical dressing can be applied at a concentration of 1.5g per 10 cm2, ten minutes before changing the wound dressing. According to the results of the study, the application of lidocaine cream with prilocaine applied directly to the wound when compared to the use of oral morphine 10 mg showed a superior analgesic effect and for a prolonged period of time. [3, 31, 12]

Topical morphine at 0.2% also showed good results in terms of pain control. This coating can be applied directly to the lesion, without restriction, and more than once throughout the day. This result corroborates the fact that peripheral opioid receptors become detectable during an inflammatory process, so it is possible to apply small doses of opioids to achieve significant analgesia. [12, 32]

Finally, the study points to the use of bactericidal solutions as an additional way of relieving local pain caused by the neoplastic wound. It was observed that local infection control, with the use of Metronidazole and Polyhexamethylene Biguanide (PHMB) dressings, helps to reduce pain in the FNM, providing greater comfort for the patient. [12, 33]

With regard to technologies related to medical equipment, the studies pointed to the use of intrathecal pumps to administer analgesia. Invasive pain control procedures for cancer patients are considered the last option on the pain control ladder by the World Health Organization. The intrathecal route corresponds to an implanted catheter, coupled to two types of pump, programmable (allowing dosage changes) and non-programmable (with continuous volume and flow) for the administration of analgesic medications, with opioids such as fentanyl, morphine and adjuvants such as ketamine being common. [31, 34]

According to the studies analyzed, intrathecal application made it possible to achieve the same levels of analgesia with lower doses of morphine compared to doses required by oral routes, for example. The intrathecal route of administration is indicated for cancer patients who find it difficult to take oral medication due to undesirable side effects, with severe pain that is difficult to control despite the high dose of opioid administered and when the main site of pain is the lower body. [9, 11, 14, 4]

The disadvantages are that it is an invasive procedure and can mask worsening symptoms such as spinal cord compression in cancer patients. In addition, this technology costs more than conventional medications. [4, 14]

And finally, the technologies related to alternative therapies for pain control found were: acupuncture/acupressure and hand-holding therapy. The prac-

DOI: 10.36489/saudecoletiva.2025v15i97p16106-16125

tices of alternative therapies associated with conventional treatments are recommended for effective pain control in cancer [36,15].

Acupuncture is a technique that originated in Chinese medicine and can be applied in a variety of ways: traditional acupuncture, electroacupuncture, microsystem acupuncture (ear acupuncture, scalp acupuncture), acupressure and moxibustion. The most common practice involves the insertion of needles into specific points on the skin indicated for pain relief and disease treatment. The study found that acupuncture and acupressure are effective in controlling pain when combined with other therapies. In addition, a reduction in the use of opioids by patients receiving this therapy was found [35,15].

In relation to Hand Imposition Therapy (HIT), these are integrative or complementary practices that aim to rebalance the health of the human being through the manipulation of Vital Energy. Examples of this practice include Reiki, Therapeutic Touch (TT) and Healing Touch (HT). According to this practice, the vital energy called Prana for the Hindus, "Chi" for the Chinese, "Ki" for the Japanese and "Orgone" for the psychiatrist Wilhelm Reich needs to be in balance. [16, 36-37]

The results of the study showed that the laying on of hands helped cancer patients to reduce their pain, especially when the treatment was personalized. In addition to reducing pain, the application of the TIM technique improves anxiety and stress. This practice is already used in patients with other chronic pathologies, such as osteoarthritis, with good results in pain control. [16, 36-38]

CONCLUSION

This study mapped pain management technologies, finding medication options, medical equipment and alternative therapies that can be applied to the treatment of cancer patients. Pain management technologies related to medications emphasize the opioid treatment line for moderate to severe pain, with the medications: Hydromorphone, Buprenorphine and Remifentanil (prototype under study). In addition to Morphine gel, topical coverings include local anesthetics and bactericides for use in malignant neoplastic wounds.

With regard to equipment, intrathecal pumps were considered an option, despite their high cost when compared to conventional treatments, mainly indicated for patients who have difficulty maintaining adequate analgesic dosage or are intolerant of other routes of administration.

With regard to alternative therapies, acupuncture and the laying on of hands show good results in pain control, either alone or in combination with other therapies, and contribute to relieving anxiety and stress.

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