Asian Journal of Health Research
Journal Homepage: https://a-jhr.com
Published by Ikatan Dokter Indonesia Wilayah Jawa Timur

Review Article

Lutetium-Specific Prostatic Membrane Antigen (LuPSMA) Treatment for Metastatic Castration-Resistant Prostate Cancer

Sanna Verena Moreira Paixão[1*], Carlos Danilo Cardoso Matos Silva[2]

[1] Undergraduate student in Biomedicine, Unidade de Ensino Superior de Feira de Santana-UNEF; Feira de Santana, Brazil
[2] Master Teacher, Unidade de Ensino Superior de Feira de Santana-UNEF; Feira de Santana, Brazil

ARTICLE HISTORY
Received: 14 July 2024
Revised: 27 August 2024
Accepted: 29 September 2024

CORRESPONDING AUTHOR*
Sanna Verena Moreira Paixão
sannafac@gmail.com
Undergraduate student in Biomedicine, Unidade de Ensino Superior de Feira de Santana-UNEF; Feira de Santana

KEYWORDS
Prostate Neoplasms; Lutetium; Positron Emission Tomography combined with Computed Tomography

This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/)

ABSTRACT

Introduction: Cancer is one of the leading causes of death globally, with the majority of cases occurring in low-income countries. There are more than a hundred types, divided into sarcomas and carcinomas. Prostate cancer is the most common cancer among men and is usually asymptomatic. Treatment depends on the stage of the disease and may include surgery, hormone therapy, and radiation therapy. In advanced stages, new treatments such as the radiopharmaceutical LuPSMA are investigated to improve patients' quality of life.

Material and Methods: An exploratory-descriptive literature review was conducted using qualitative methods. Data collection spanned 2019–2024, sourcing relevant studies from LILACS, SciELO, and PubMed. Search terms included "Prostate Neoplasms," "Lutetium," and "Positron Emission Tomography combined with Computed Tomography," using both Portuguese and English with the boolean operator "AND." After screening 189 articles for relevance, 30 met the inclusion criteria.

Results: Theranostic treatment with LuPSMA demonstrated significant improvements in overall survival and progression-free survival in mCRPC patients. The therapy was well-tolerated, with manageable adverse effects. However, challenges remain in predicting outcomes for patients with low PSMA expression.

Conclusion: LuPSMA therapy has shown promise in enhancing survival rates and quality of life for mCRPC patients, offering a well-tolerated alternative to conventional treatments. However, there are uncertainties about the therapeutic response and prognosis in patients with low PSMA expression, indicating the need for further research. The study has contributed to imaging and oncology, offering new perspectives on alternative therapies for metastatic cancer and serving as a basis for future investigations into imaging-guided radionuclide therapies.

Cite this as: Paixão SVM, Silvia CDCM (2024) Lutetium-Specific Prostatic Membrane Antigen (LuPSMA) Treatment for Metastatic Castration-Resistant Prostate Cancer. *Asian J Heal Res.* 3 (3): 278–285. doi: 10.55561/ajhr.v3i3.182

INTRODUCTION

Cancer is the second most common cause of death worldwide, with the majority of them, approximately 70%, in middle- and low-income countries. In 2018 alone, cancer claimed an average of 9.6 million victims. It can be defined as the uncontrolled growth of malignant cells, which can be developed by genetic predispositions, ethnicity, and external factors, such as lifestyle, diet, smoking, and alcoholism [1]. Science knows more than a hundred types of cancers at first. They can be divided into two large groups these are sarcomas when they arise in connective tissues, and carcinomas, which originate from epithelial tissues which, in turn, cover most organs [2].

Among carcinomas, prostate cancer can be mentioned as the most common adenocarcinoma among men [3]. Carcinomas receive the prefix "adeno" when they affect glands, in this case, the prostate, an exclusively male organ that is part of the genital system. This type of cancer is considered elderly since almost 80% of cases affect men from the age of 65; this statistic can be explained by the fact that it is a slow-developing cancer since it can take up to 15 years for the tumor to

reach one cm^3, remaining unnoticed for years and possibly being discovered later than expected, being in the metastatic phase, for example [2].

Most individuals with prostate cancer are diagnosed asymptomatic, with Prostate Specific Antigen (PSA) being one of the most important tests, as well as digital rectal examination; other patients may have urinary obstruction, pain located in the prostate region, and, if in the metastatic phase, pain in the bones, even causing fractures [4]. The treatment will be chosen depending on the clinical characteristics of the individual, and surgery and Transurethral Resection (TR) may be performed in localized tumors, association with hormone therapy in locally advanced tumors, androgen blockade or surgical castration in cases of metastasis [5].

Traditional treatments may not present significant results in the metastatic phase since the latest protocols aim to improve the quality of the end-of-life of these individuals, as there is no reduction in tumors. Thus, it is necessary to know how the Lutetium-Prostatic Membrane Antigen (LuPSMA) radiopharmaceutical can help in the treatment of patients with metastatic prostate cancer.

MATERIAL AND METHODS

This was an exploratory-descriptive bibliographic study with a qualitative approach, and the data was used to elaborate on the scientific article. According to Gil (2022) [6], bibliographic research is developed based on material already prepared, consisting mainly of books and scientific articles; that is, it is the one in which the theoretical survey of a given subject is carried out from the collection of information about what different authors report on the subject.

A study has an exploratory nature when it involves a bibliographic survey, interviews with people who have had (or have) practical experiences with the researched problem, and analysis of examples that stimulate understanding. It also has the basic purpose of developing, clarifying, and modifying concepts and ideas for the formulation of subsequent approaches. Thus, this type of study aims to provide greater knowledge for the researcher about the subject so that he can formulate more precise problems or create hypotheses that can be researched by future studies [6].

According to Gonçalves (2003) [7], descriptive research records, analyzes, classifies, and interprets the observed facts, often establishing relationships between them. As for the approach, this study is qualitative. Minayo (1994) describes that qualitative research is one whose concern of the researcher is not directed to the quantitative profile of the data, but rather to the value of the information that can be collected, correlating the phenomena and variables to reality, in order to understand this experience in deeper dimensions, encompassing creativity and directing to the construction of scenarios and new perspectives within the same reality. Data collection was based on a bibliographic survey carried out through research carried out on scientific productions on the proposed theme from 2019 to 2024.

The inclusion criteria for the selection of content were those published in full according to the theme, documents, regulations, regulations of health entities on the theme, and articles without language restrictions. The exclusion criteria were articles that were not relevant to the theme, duplicate materials, incomplete materials, debates, reviews, abstracts, and materials not available in full. The literature search was carried out using the following databases: Latin American and Caribbean Literature in Health Sciences (LILACS), the Virtual Scientific *Electronic Library Online* (SciELO), and *the National Library of Medicine* (PubMed). It is noteworthy that the LILACS database was consulted through the Virtual Health Library (VHL). The searches were performed using the Health Sciences Descriptors (DeCS) of the Regional Library of Medicine (Bireme): Prostate Neoplasms, Lutetium, and Positron Emission Tomography combined with Computed Tomography, in Portuguese and English with the aid of the Boolean operator "AND".

The methodology used in this study began with the careful selection of keywords in DeCS (Health Sciences Descriptors), followed by searches in several indexed databases, including PubMed, Virtual Health Library (VHL), and SciELO. Using both the selected keywords and their alternative terms, tables were prepared containing all the pertinent articles related to the searches with the corresponding descriptors and alternative terms in each database consulted. Duplicate articles were eliminated in each table, and a selection by title relevance was conducted. After this screening, the selected articles were submitted to the reading of the abstracts, and those that met the established relevance criteria were included for exhaustive reading.

For the comprehensive analysis of the selected articles, four axes of discussion were identified, which were outlined based on the specific objectives of the study and transformed into guiding questions. Such questions guided the reading of the selected articles, providing a conceptual framework for the critical and in-depth analysis of the information contained in them. The answers obtained for each question from the exhaustive reading of the articles constituted the basis for the writing of the results and the conduction of the discussion, thus enriching the analysis and

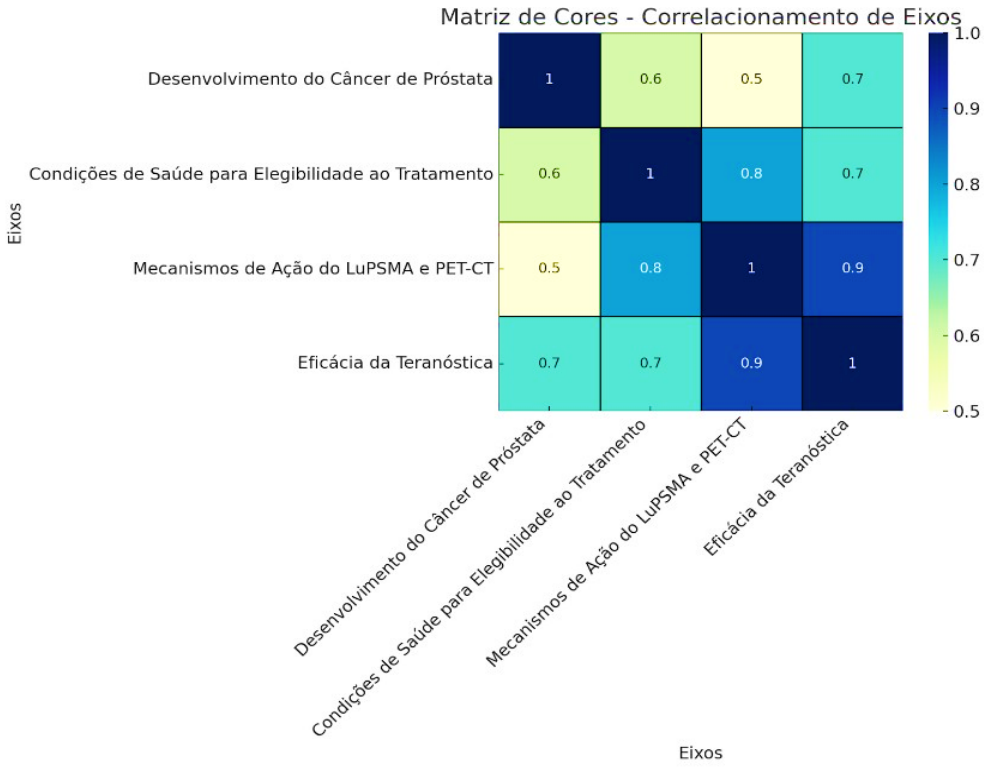


Figure 1. Color Matrix – Axis Correlation (Source: Prepared by the author)

interpretation of the data. This structured and meticulous methodology provided a systematic and reasoned investigation of the relevant literature, reinforcing the validity and robustness of the results presented in this scientific study.

RESULTS

To carry out this final course work, 189 articles were found, already unifying those found in different databases and excluding duplicates, using the descriptors "Prostate Neoplasms", "Lutetium" and "Positron Emission Tomography combined with Computed Tomography" in Portuguese and English, associated by the Boolean operator "AND", in the PubMed and LILACS databases, being LILACS consulted through the VHL. In the SciELO database, no studies were found using the descriptors used. Having the articles in a table, after reading the titles and abstracts, a total of 30 relevant scientific articles on LuPSMA treatment for mCRPC were selected and analyzed. The inclusion criteria adopted involved articles published between 2019 and 2024 without language restrictions and focused mainly on presenting the results of the proposed theranostics. Studies that did not meet the established relevance criteria or that were not fully available were excluded.

A colour matrix was generated to present the correlation between the four axes discussed relating to mCRPC and treatment with LuPSMA in conjunction with PET-CT (Fig.2). The strongest correlations observed are between the mechanisms of action of LuPSMA and PET-CT and the efficacy of theranostics (0.9), suggesting that the efficacy of treatment is highly dependent on how these mechanisms work. In addition, the health conditions for eligibility for treatment show a high correlation (0.8) with the mechanisms of action of LuPSMA and PET-CT and with the efficacy of theranostics (0.7), indicating that patients' health is highly relevant to the efficacy of these mechanisms.

DISCUSSION

Pathophysiology of Prostate Cancer

Prostate cancer is defined as a neoplasm originating in the tissues of the prostate and is the second most commonly diagnosed neoplasm in the male population worldwide [8]. This type of cancer develops when cells in the prostate, a gland of the male reproductive system, begin to grow in an uncontrolled way influenced by

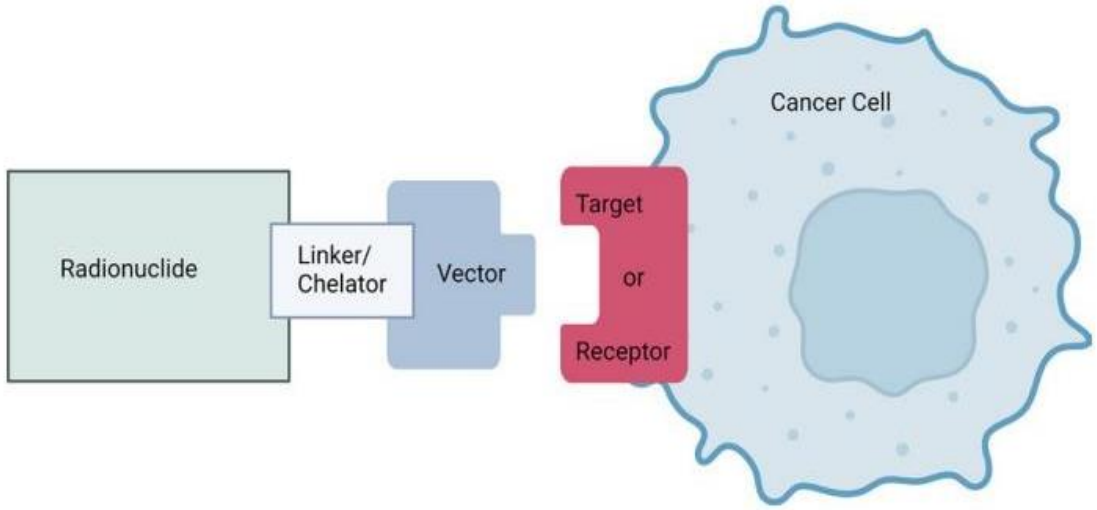


Figure 2. Radionuclide Therapy Regimen (Source: Burkett et al., 2023)

genetic, hormonal, and environmental factors, resulting in malignant tumors that can spread to other parts of the body [9,10,11].

Genetic and epigenetic alterations play a crucial role in the malignant transformation of prostate cells, affecting the mechanisms of regulation of cell growth and apoptosis [5,12]. Generally, prostate cancer develops slowly and may not cause symptoms for many years. When symptoms do occur, they may include difficulty urinating, blood in the urine or semen, pain in the pelvic region, and pain during ejaculation [4].

Metastatic castration-resistant prostate cancer (mCRPC) is established in patients with suppressed testosterone levels <50 ng/dL and at least one of the following criteria: biochemical progression, defined as an increase in PSA in studies spaced at least one week apart, with two increases of 50% above the nadir value, and with PSA >2 ng/mL, or radiological progression with two or more new lesions on bone scan or soft tissue lesions [8,13,14]. This condition poses a significant challenge in treatment, as cancer cells become less responsive to traditional androgen deprivation (ADT) therapies [15].

Therapy for prostate cancer, especially in advanced stages, involves a combination of approaches, including surgery, radiation therapy, and hormone therapy. In cases of mCRPC, radioligand therapy using Lu-177-PSMA-617 (LuPSMA) has shown efficacy, working in conjunction with Positron Emission Tomography combined with Computed Tomography (PET-CT) to monitor disease progression and response to treatment [16].

Main Health Conditions for The Patient to be Eligible for Treatment

Patients eligible for LuPSMA treatment must be adults, have mCRPC and symptoms of bone metastasis, have undergone all previously recommended and approved therapies such as antiandrogen therapy and chemotherapy, and have failed effective regular treatments [17]. It is essential to be in good health; patients with clinically significant impaired medullary, hepatic, or renal function are not eligible for treatment [8,18,19]. In addition, patients must have an ECOG performance status of 0 to 2 and a life expectancy of at least six months [10,14].

Before starting treatment with LuPSMA, patients should undergo a staging through PET-CT with [68Ga] Ga-PSMA-11, with reassessment after two cycles of LuPSMA [11,19]. It is necessary for these patients to have a significant expression of PSMA, detected through imaging tests, such as PET-CT, to ensure the effectiveness of the therapy since the local binding of the ligand in the tumor is essential to administer the radiation dose correctly [17,18,20,21].

Eligibility is further determined by appropriate laboratory parameters such as PSA, alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), and C-reactive protein (CRP) levels, which help monitor treatment response and overall patient health [22]. Careful assessment of the patient's overall health and the absence of coexisting severe medical conditions are essential to ensure that treatment is safe and effective, providing a better quality of life and potentially extending survival [15,23].

Mechanisms of Action of LuPSMA in Conjunction with PET-CT

A radionuclide can be stabilized by a chelator, a cage, or a covalent bond and then coupled to a vector by means of a ligand molecule. This vector connects to a specific molecular target, allowing visualization of the target for diagnosis or treatment, as well as enabling targeted delivery of radiation therapy to the desired site. Alternatively, a free radionuclide ion can be used, under certain conditions, to reach tumors or cancer cells (**Fig.1**).

Prostate-specific membrane antigen (PSMA) is a transmembrane protein that is highly expressed in most prostate carcinoma cells, offering a starting point for diagnosis and therapy. PET-CT with [68Ga]Ga-PSMA-11 allows for diagnosing and staging prostate cancer, identifying tumor lesions that express PSMA, and determining the extent of the disease [8,20,28]. This assessment is crucial for selecting patients and for assessing response to LuPSMA treatment.

In the theranostic in question, LuPSMA is a radiopharmaceutical that binds to PSMA expressed on tumor cells. After administration, it emits beta radiation, destroys PSMA-positive cancer cells, and preserves the surrounding healthy tissues. In addition, it emits a small amount of gamma radiation, enabling imaging research of the cells marked by PET-CT [20,24].

PET-CT, as it allows visualizing the precise location of the radiopharmaceutical in the body and quantifying the PSMA capture of tumors, will be used for diagnosis, staging, patient selection, and treatment follow-up [11,21].

Theranostics Efficacy

The efficacy of theranostics, which includes the use of LuPSMA in conjunction with PET-CT, is promising for the treatment of mCRPC. The use of PSMA-PET-CT to guide patient selection for radionuclide therapy allows for a personalized approach with proven and potentially more effective diagnostic utility, and its application in the detection of biochemical relapses demonstrates a significant change in treatment plans and improved clinical outcomes [24–26].

The mechanism of action of radionuclide therapies is characterized by a highly selective effect on the tumor, with often low toxicity. Treatment of prostate cancer with radium dichloride (Ra-223) was the first radionuclide therapy to show survival benefit; however, due to its mechanism of action, it is not effective in visceral metastases or large lymph node metastases. In contrast, LuPSMA targets all tumor locations and has an excellent combination of survival benefits with few side effects [20,27].

Retrospective and prospective studies have demonstrated a significant reduction in PSA levels and a positive response in a substantial percentage of patients treated with LuPSMA. Yadav et al. (2020) report that in one study, after 2 to 3 months of the first therapy, more than 50% decline in PSA was observed in 32.2% of patients, and this proportion increased to 45.5% [28]. By the end of the evaluation. The disease control rate was 77%, and the median overall survival was 14 months. Phase III trials are further investigating the efficacy and role of this therapeutic approach in the management of mCRPC [17].

In 2021, the VISION study, an international phase III study of 831 patients with mCRPC who progressed after antiandrogen therapy and chemotherapy, showed that LuPSMA provided significantly higher overall survival, longer progression-free survival compared to standard care, as well as emotional functionality and reduction of symptoms such as fatigue and pain [8,10–12,14,15,19–21,29].

Therapy was well tolerated, with haematological adverse effects such as anaemia and thrombocytopenia being the most common but generally manageable. The efficacy of therapy was correlated with treatment dose, with higher doses resulting in higher PSA response rates and disease control, although this was also associated with a higher risk of hematologic toxicity [18].

However, there is still an unresolved clinical question about identifying the patients with mCRPC who will benefit from LuPSMA therapy. The efficacy of theranostics depends on the expression of PSMA measured by PSMA-PET-CT; it is still unclear to what extent this expression can predict therapeutic response and predict overall survival and a meticulous evaluation of imaging results is necessary to adjust treatment [16,30]. There is a need for therapies with a different target that are better tolerated, as not all current therapies are effective or suitable for patients with mCRPC, and effective therapies may also increase toxicity over time [20].

CONCLUSION

The results indicate that LuPSMA provided significantly higher overall survival and longer progression-free survival compared to standard treatment, being a well-tolerated therapy with manageable adverse effects. However, some limitations have been identified, such as uncertainty about the therapeutic response and prognosis of overall survival in patients with low PSMA expression, which suggests that future research should consider methods for the efficacy of this treatment in patients with low PSMA expression.

In conclusion, this study contributed to the fields of imaging and oncology, offering new perspectives on alternative therapies, especially in cases of metastatic

cancer. It is hoped that the findings presented here will serve as a basis for future investigations that seek to deepen the knowledge about radionuclide therapies guided by imaging tests.

ACKNOWLEDGMENT

We thank all the authors of the articles reviewed in this article.

CONFLICT OF INTEREST

The authors declare there is no conflict of interest.

REFERENCES

1. Ávila, Carlos; Cadavid, Tatiana; Martínez, Maria Cristina; Varela, Humberto; Hernández- Hidalgo, Nathalie (2024) Care Pathway at a Cancer Center for the Administration of Radiometabolic Therapy with 177Lu-PSMA in Patients with Metastatic Castration-resistant Prostate Cancer. Molecular Imaging and Radionuclide Therapy, [S.l.], v.33, n.1, p.28-37. DOI 10.4274/mirt.galenos.2023.82653. Available in: https://pubmed.ncbi.nlm.nih.gov/38390762/. Access in: 5 Jul. 2024.
2. Beyersdorff, Dirk; Rahbar, Kambiz; Essler, Markus; Ganswindt, Ute; Grosu, Anca-Ligia; Gschwend, Jürgen E; Miller, Kurt; Scheidhauer, Klemens; Schlemmer, Heinz-Peter; Wolff, Johannes Maria; Krause, Bernd Joachim (2021) [Interdisciplinary expert consensus on innovations in imaging diagnostics and radionuclide-based therapies for advanced prostate cancer]. Der Urologe Ausg. A, [S.l.], v.60, n.12, p.1579-1585. DOI 10.1007/s00120-021-01598-2. Available in: https://pubmed.ncbi.nlm.nih.gov/34406465/. Access in: 6 Jul. 2024.
3. Brasil. Instituto Nacional de Câncer - INCA. Câncer de próstata – Assuntos: Câncer: Tipos de Câncer. Brasília. (2023). Available in: https://www.gov.br/inca/pt-br/assuntos/cancer/tipos/prostata. Access in: 5 Jul. 2024.
4. Brasil. Ministério da Saúde. Câncer – Assuntos: Saúde de A a Z. Brasília (2020) Available in: https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/c/cancer. Access in: 5 Jul. 2024
5. Burgard, Caroline; Rosar, Florian; Marlowe, Robert J; Bartholomä, Mark; Dewes, Sebastian; Schaefer-Schuler, Andrea; Linxweiler, Johannes; Khreish, Fadi; Ezziddin, Samer (2023) Tumor Sink Effect with Prostate-Specific Membrane Antigen-Targeted Theranostics in Patients with Metastatic Castration-Resistant Prostate Cancer: Intra-Individual Evaluations. Cancers, [S.l.], v.15, n.9, p.2592-2607, DOI: 10.3390/cancers15092592. Available in: https://pubmed.ncbi.nlm.nih.gov/37174058/. Access in: 6 Jul. 2024.
6. Burkett, Brian J; Bartlett, David J; McGarrah, Patrick W; Lewis, Akeem R; Johnson, Derek R; Berberoglu, Kezban; Pandey, Mukesh K; Packard, Annie T; Halfdanarson, Thorvardur R; Hruska, Carrie B; Johnson, Geoffrey B; Kendi, A Tuba (2023) A Review of Theranostics: Perspectives on Emerging Approaches and Clinical Advancements. Radiology Imaging Cancer, [S.l.], v.5, n.4, p.1–16, 2023. DOI 10.1148/rycan.220157. Available in: https://pubmed.ncbi.nlm.nih.gov/37477566/. Access in: 6 Jul. 2024.
7. Chandran, Elias; Figg, William D; Madan, Ravi (2022) Lutetium-177-PSMA-617: A Vision of the Future. Cancer Biology and Therapy, [S.l.], v.23, n.1, p.186–190, DOI 10.1080/15384047.2022.2037985. Available in: https://pubmed.ncbi.nlm.nih.gov/35220877/. Access in: 6 Jul. 2024.
8. Farolfi, Andrea; Fendler, Wolfgang; Iravani, Amir; Haberkorn, Uwe; Hicks, Rodney; Herrmann, Ken; Walz, Jochen; Fanti, Stefano (2019) Theranostics for Advanced Prostate Cancer: Current Indications and Future Developments. European Urology Oncology, [S.l.], v.2, n.2, p.152-162, 2019. DOI 10.1016/j.euo.2019.01.001. Available in: https://pubmed.ncbi.nlm.nih.gov/31017091/. Access in: 5 Jul. 2024.
9. Georgakopoulos, Alexander; Bamias, Aristotle; Chatziioannou, Sophia (2023) Current role of PSMA-PET imaging in the clinical management of prostate cancer. Therapeutic Advances in Medical Oncology, [S. l.], v. 15, p. 1–10, 2023. DOI 10.1177/17588359231208960. Available in: https://pubmed.ncbi.nlm.nih.gov/38028141/. Access in: 6 Jul. 2024.
10. Gil, Antonio Carlos (2022) Como Elaborar Projetos de Pesquisa. 7. ed. atual. Brasil: Atlas, ISBN 6559771636
11. Gonçalves, Hortência de Abreu (2021) Manual de Projetos de Pesquisas Científicas. 3. ed. [s.I]: Avercamp
12. Iravani, Amir; Violet, John; Azad, Arun; Hofman, Michael S. (2020) Lutetium-177 prostate-specific membrane antigen (PSMA) theranostics: practical nuances and intricacies. Prostate Cancer and Prostatic Diseases, [S. l.], v.23, n.1, p. 38–52, DOI 10.1038/s41391-019-0174-x. Available in:

https://pubmed.ncbi.nlm.nih.gov/31595044/. Access in: 6 Jul. 2024.

13. Kafka, Mona; Horninger, Andreas; di Santo, Gianpaolo; Virgolini, Irene; Neuwirt, Hannes; Unterrainer, Lena M; Kunte, Sophie C; Deiss, Emil; Paffenholz, Pia; Heidenreich, Axel; Rasul, Sazan; Einspieler, Holger; Shariat, Shahrokh F; Rajwa, Pawel; Dozauer, Robert; Tsaur, Igor; Medlock, Ellen; Rölz, Niklas; Rausch, Steffen; la Fougère, Christian; Trautwein, Nils; Roesch, Marie C; Merseburger, Axel S; Zattoni, Fabio; Sepulcri, Matteo; Ladurner, Michael; Bektic, Jasmin; Gandaglia, Giorgio; Horninger, Wolfgang; Heidegger, Isabel (2024) Real-world Outcomes and Predictive Biomarkers for 177 Lutetium Prostate-specific Membrane Antigen Ligand Treatment in Metastatic Castration-resistant Prostate Cancer: A European Association of Urology Young Academic Urologists Prostate Cancer Working Group Multi-institutional Observational Study. European Urology Oncology, [S. l.], v. 7, n. 3, p. 421-429, 2024. DOI 10.1016/j.euo.2023.07.018. Available in: https://pubmed.ncbi.nlm.nih.gov/37604763/. Access in: 6 jul. 2024.
14. Kamaldeep; Wanage, Gaurav; Sahu, Sudeep Kumar; Maletha, Pravind; Adnan, Aadil; Suman, Sonam; Basu, Sandip; Das, Tapas; Banerjee, Sharmila (2021) Examining Absorbed Doses of Indigenously Developed 177Lu-PSMA-617 in Metastatic Castration-Resistant Prostate Cancer Patients at Baseline and During Course of Peptide Receptor Radioligand Therapy. Cancer Biotherapy and Radiopharmaceuticals, [S.l.], v. 36, n. 3, p. 292–304, DOI 10.1089/cbr.2020.3640. Available in: https://pubmed.ncbi.nlm.nih.gov/32379495/. Access in: 6 Jul. 2024.
15. Karimzadeh, Amir; Soeiro, Paula; Feuerecker, Benedikt; Hecker, Charlotte-Sophie; Knorr, Karina; Heck, Matthias M.; Tauber, Robert; D'Alessandria, Clogero; Weber, Wolfgang A.; Eiber, Matias; Rauscher, Isabel (2023) Improved Quality of Life in Metastatic Castration-Resistant Prostate Cancer Patients Receiving Consecutive Cycles of 177Lu-PSMA I&T. Journal of Nuclear Medicine, [S.l.], 2023, v.64, n.11, p.1765-171, DOI 10.2967/jnumed.123.265878. Available in: https://pubmed.ncbi.nlm.nih.gov/37678925/. Access in: 5 Jul. 2024.
16. Luining, Wietske I; Cysouw, Matthijs C F; Meijer, Dennie; Hendrikse, N Harry; Boellaardd, Ronald; Vis, André N; Oprea-Lager, Daniela E (2022) Targeting PSMA Revolutionizes the Role of Nuclear Medicine in Diagnosis and Treatment of Prostate Cancer. Cancers, [S. l.], v. 14, n. 5, 2022. 1169, p. 1–15. DOI 10.3390/cancers14051169. Available in: https://pubmed.ncbi.nlm.nih.gov/35267481/. Access in: 6 Jul. 2024
17. Neubauer, Moritz C; Nicolas, Guilherme P; Bauman, Andréas; Fani, Melpomeni; Nitzsche, Egberto; Afshar-Oromieh, Ali; Forrer, Flávio; Rentsch, Cirilo; Stenner, Frank; Templeton, Arnoud; Schäfer, Niklaus; Selvagem, Damian; Chirindel, Alin; all investigators on behalf of the SSNM Therapy Working Group (2024) Early response monitoring during [177Lu]Lu-PSMA I&T therapy with quantitated SPECT/CT predicts overall survival of mCRPC patients: Subgroup analysis of a Swiss-wide prospective registry study. European Journey of Nuclear Medicine and Molecular Imaging, [S. l.], v. 51, n. 4, p. 1185-1193, 2024. DOI 10.1007/s00259-023-06536-2. Available in: https://pubmed.ncbi.nlm.nih.gov/38038755/. Access in: 5 Jul. 2024.
18. OPAS/OMS–Câncer (2024) Organização Pan-Americana da Saúde. Available in: https://www.paho.org/pt/topicos/cancer. Access in: 5 Jul. 2024.
19. Sartor, Oliver; Bono, Johan de; Chi, Kim N; Fizazi, Karim; Herrmann, Ken; Rahbar, Kambiz; Tagawa, Scott T; Nordquist, Lucas T; Vaishampayan, Nitin; El-Haddad, Ghassan; Park, Chandler H; Beer, Tomasz M; Armour, Alison; Pérez-Contreras, Wendy J; Desilvio, Michelle; Kpamegan, Euloge; Gericke, Germo; Messmann, Richard A; Morris, Michael J; Krause, Bernd J; VISION Investigators. (2021) Lutetium-177-PSMA-617 for Metastatic Castration-Resistant Prostate Cancer. The New England Journal of Medicine, [S.l.], v.385, n.12, p.1091-1103, DOI 10.1056/NEJMoa2107322. Available in: https://pubmed.ncbi.nlm.nih.gov/34161051/. Access in: 6 Jul. 2024.
20. Seifert, Robert; Kessel, Katharina; Schlack, Katrin; Weckesser, Matthias; Kersting, David; Seitzer, Konstantin E; Weber, Manuel; Bögemann, Martin; Rahbar, Kambiz (2021) Total tumor volume reduction and low PSMA expression in patients receiving Lu-PSMA therapy. Theranostics, [S.l.], v.11, n.17, p. 8143-8151, DOI 10.7150/thno.60222. Available in: https://pubmed.ncbi.nlm.nih.gov/34373733/. Access in: 6 Jul. 2024.
21. Seifert, Robert; Seitzer, Konstantin; Herrmann, Ken; Kessel, Katharina; Schäfers, Michael; Kleesiek, Jenn; Weckesser, Matthias; Boegemann, Martin; Rahbar, Kambiz (2020) Analysis of PSMA expression and outcome in patients with advanced Prostate Cancer receiving 177Lu- PSMA-617 Radioligand Therapy. Theranostics, [S.l.], v. 10, n.17, p.7812-7820. DOI 10.7150/thno.47251. Available in:

https://pubmed.ncbi.nlm.nih.gov/32685021/. Access in: 6 Jul. 2024.

22. Seifert, Robert; Telli, Tugce; Hadaschik, Boris; Fendler, Wolfgang P; Kuo, Phillip H; Herrmann, Ken. (2023) Is 18F-FDG PET Needed to Assess 177Lu-PSMA Therapy Eligibility? A VISION-like, Single-Center Analysis. Journal of Nuclear Medicine, [S.l.], v.64, n.5, p.731-737. DOI 10.2967/jnumed.122.264741. https://pubmed.ncbi.nlm.nih.gov/36522186/. Acesso em: 6 Jul. 2024.
23. Straub, Manuela; Kupferschläger, Jürgen; Higuita, Lina Maria Serna; Weissinger, Matias; Dittmann, Helmut; Fougère, Christian la; Fiz, Francesco. (2023) Dual-Time-Point Posttherapy 177Lu-PSMA-617 SPECT/CT Describes the Uptake Kinetics of mCRPC Lesions and Prognosticates Patients 'Outcome. The Journal of Nuclear Medicine, [S.l.], 2023, v.64, n. 9, p. 1431-1438, DOI 10.2967/jnumed.122.264770. Available in: https://pubmed.ncbi.nlm.nih.gov/37414446/. Access in: 5 Jul. 2024
24. Suman, Sonam; Parghane, Rahul V; Joshi, Amit; Prabhash, Kumar; Bakshi, Ganesh; Talole, Sanjay; Banerjee, Sharmila; Basu, Sandip (2019) Therapeutic efficacy, prognostic variables and clinical outcome of 177Lu-PSMA-617 PRLT in progressive mCRPC following multiple lines of treatment: prognostic implications of high FDG uptake on dual tracer PET-CT vis-à-vis Gleason score in such cohort. The British Journal of Radiology, [S. l.], v. 92, n.1104, p.01-12, DOI 10.2967/jnumed.122.264770. Available in: https://pubmed.ncbi.nlm.nih.gov/37414446/. Access in: 6 Jul. 2024.
25. Van Golen, Larissa W; Vogel, Wouter; Lam, Marnix G. E. H. (2023) [Lutetium-177-PSMA in metastasized prostate carcinoma]. Ned Tijdschr Geneeskd, [S.l.], v.166, n.1, https://pubmed.ncbi.nlm.nih.gov/36927799/. Access in: 02 May. 2024.
26. Violet, John; Jackson, Price; Ferdinandus, Justin; Sandhu, Shahneen; Akhurst, Tim; Iravani, Amir; Kong, Grace; Kumar, Aravind Ravi; Thang, Sue Ping; Eu, Peter; Scalzo, Mark; Murphy, Declan; Williams, Scott; Hicks, Rodney J; Hofman, Michael S. (2019) Dosimetry of 177Lu- PSMA-617 in Metastatic Castration-Resistant Prostate Cancer: Correlations Between Pretherapeutic Imaging and Whole-Body Tumor Dosimetry with Treatment Outcomes. Journal of Nuclear Medicine, [S. l.], v. 60, n. 4, p. 517–523, DOI 10.2967/jnumed.118.219352. Available in: https://pubmed.ncbi.nlm.nih.gov/30291192/. Access in: 6 Jul. 2024.
27. Vlachostergios, Panagiotis J; Niaz, Muhammad Junaid; Skafida, Myrto; Mosallaie, Seyed Ali; Thomas, Charlene; Christos, Paulo J; Osborne, Joseph R.; Molina, Ana M; Nanus, David M; Bander, Neil Harrison; Tagawa, Scott T. (2021) Imaging expression of prostate-specific membrane antigen and response to PSMA-targeted β-emitting radionuclide therapies in metastatic castration-resistant prostate cancer. The Prostate, [S. l.], v. 81, n. 5, p. 279–285, DOI 10.1002/pros.24104. Available in: https://pubmed.ncbi.nlm.nih.gov/33465252/. Access in: 6 Jul. 2024.
28. Yadav, Madhav Prasad; Ballal, Sanjana; Bal, Chandrashekhar; Sahoo, Ranjit Kumar; Damle, Nishikant Avinash; Tripathi, Madhavi; Seth, Amlesh (2020) Efficacy and Safety of 177Lu-PSMA-617 Radioligand Therapy in Metastatic Castration-Resistant Prostate Cancer Patients. Clinical Nuclear Medicine, [S. l.], v. 45, n. 1, p. 19-31, DOI 10.1097/RLU.0000000000002833. Available in: https://pubmed.ncbi.nlm.nih.gov/31789908/. Access in: 6 Jul. 2024
29. Zang, Jie; Fan, Xinrong; Wang, Hao; Liu, Qingxing; Wang, Jingnan; Li, Hui; Li, Fang; Jacobson, Orit; Niu, Gang; Zhu, Zhaohui; Chen, Xiaoyuan (2019) First-in-human study of 177Lu-EB-PSMA-617 in patients with metastatic castration-resistant prostate cancer. European Journey of Nuclear Medicine and Molecular Imaging, [S. l.], v. 46, n. 1, p. 148-158, DOI 10.1007/s00259-018-4096-y. Available in: https://pubmed.ncbi.nlm.nih.gov/30090965/. Access in: 6 Jul. 2024.
30. Zang, Jie; Liu, Qingxing; Sui, Huimin; Wang, Rongxi; Jacobson, Orit; Fan, Xinrong; Zhu, Zhaohui; Chen, Xiaoyuan (2020) 177Lu-EB-PSMA Radioligand Therapy with Escalating Doses in Patients with Metastatic Castration-Resistant Prostate Cancer. Journal of Nuclear Medicine, [S. l.], v. 61, n. 12, p. 1772-1778, DOI 10.2967/jnumed.120.242263. Available in: https://pubmed.ncbi.nlm.nih.gov/32358086/. Access in: 6 Jul. 2024.