

XXXIII CONGRESSO NAZIONALE AIRO

# AIRO2023

BOLOGNA,  
27-29 OTTOBRE 2023

PALAZZO DEI CONGRESSI

Radioterapia Oncologica: l'evoluzione al servizio dei pazienti

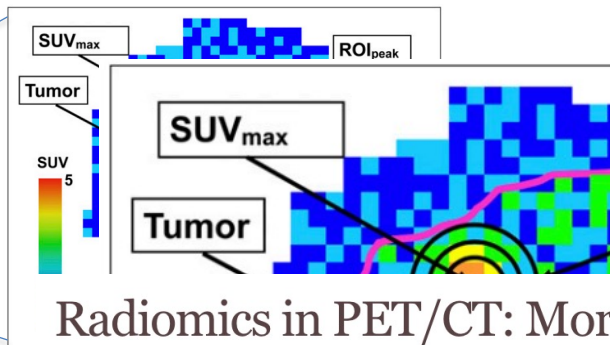
**Intelligenza Artificiale, come cambierà  
il futuro delle nostre discipline: SIRM, AIMN, AIRO  
Il punto di vista del medico nucleare  
Giulia Santo**

<sup>1</sup>Department of Experimental and Clinical Medicine, "Magna Graecia" University of Catanzaro, Catanzaro, Italy.

<sup>2</sup>Department of Nuclear Medicine, Medical University of Innsbruck, Innsbruck, Austria.



Associazione Italiana  
Radioterapia e Oncologia clinica



## Radiomics in PET/CT: More Than Meets the Eye?

Mathieu Hatt, Florent Tixier, Dimitris Visvikis and Catherine Cheze Le Rest

Journal of Nuclear Medicine March 2017, 58 (3) 365-366; DOI: <https://doi.org/10.2967/jnumed.116.184655>

Article

Info & Metrics

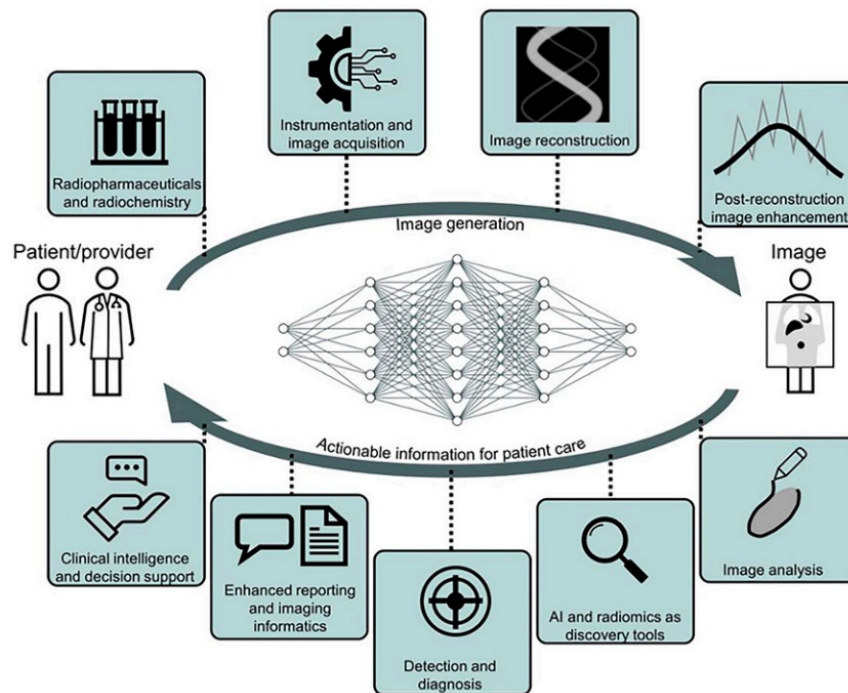
PDF

Radiomics is defined as the high-throughput extraction of quantitative metrics from medical images (1). One of its main assumptions is that medical images are considered not merely pictures for visual assessment but rather minable quantitative data (2) that may not necessarily be captured by the human eye (3).



- **A**ugmented **I**mages
- **A**ssisted **I**nterpretation
- **A**dditional **I**nsight
- **A**ccelerated Imaging **I**ntegration

Inspired by Irene Buvat



Saboury et al. J Nucl Med, 2023

## Augmented Images

### ➤ Riduzione dell'attività somministrata

Katsari et al. *EJNMMI Physics* (2021) 8:25  
<https://doi.org/10.1186/s40658-021-00374-7>

EJNMMI

#### ORIGINAL RESEARCH

### Artificial intelligence for reduced dose 18F-FDG PET examinations: a real-world deployment through a standardized framework and business case assessment

Katia Katsari<sup>1</sup>, Daniele Penna<sup>2</sup>, Vincenzo Arena<sup>2</sup>, Giulia Polverari<sup>2</sup>, Annarita Ianniello<sup>2</sup>, Domenico Italo Rolando Milani<sup>2</sup>, Alessandro Roncacci<sup>3</sup>, Rowland O. Illing<sup>3,4</sup> and Ettore Pelosi<sup>2\*</sup>

Age

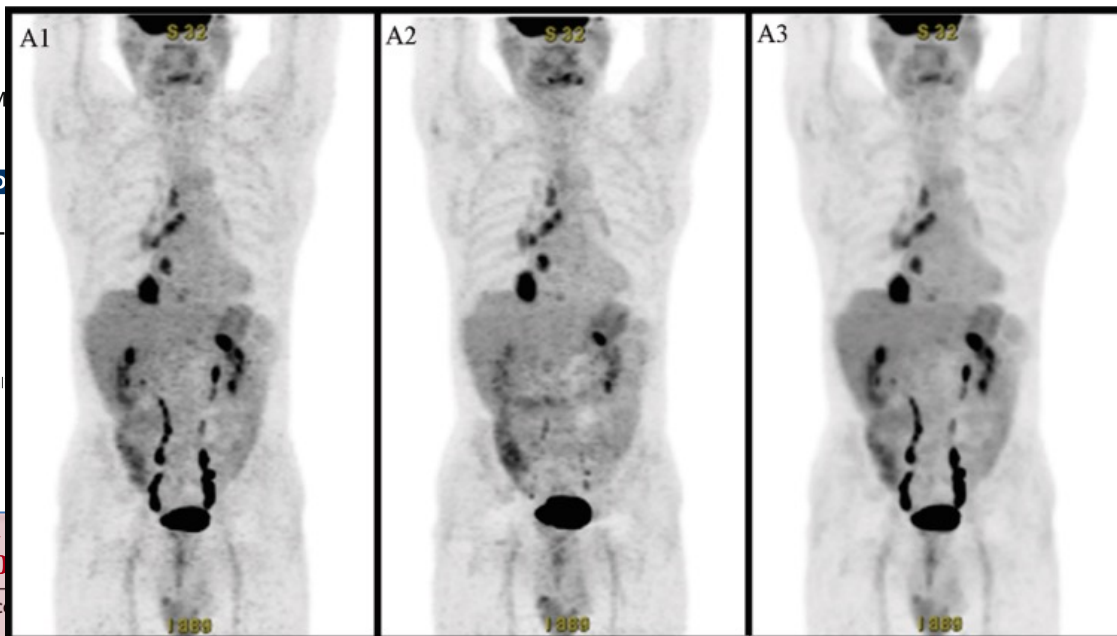
Body weight

Dose injected (study protocol)

Reference dose (standard procedure)<sup>a</sup>

**-33%**

<sup>a</sup>These values represent the routine administered dose of 18F-FDG according to standard care procedures

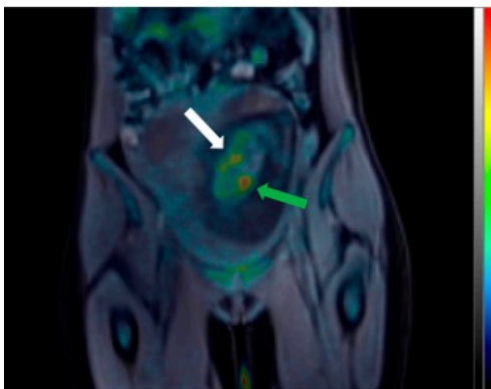


QUALE DI QUESTE IMMAGINI E' STATA PROCESSATA CON AI?



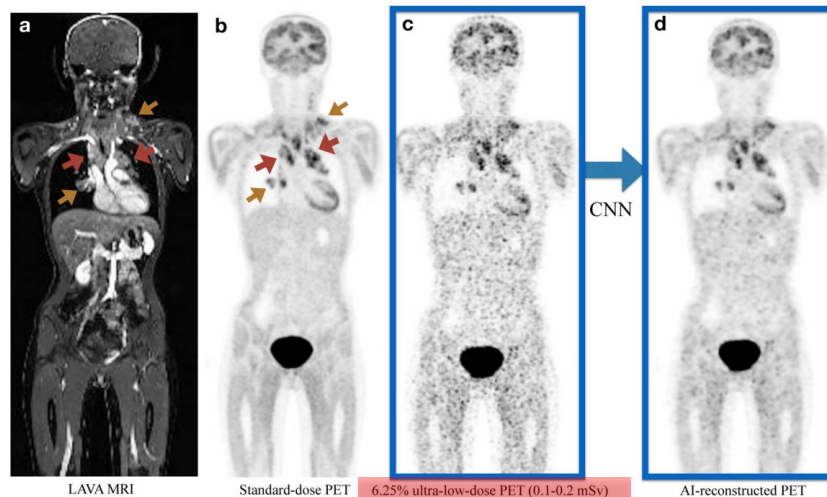
## CLINICAL TRANSLATION

- Ridurre la dose al feto



Zanotti-Fregonara et al. J Nucl Med, 2015

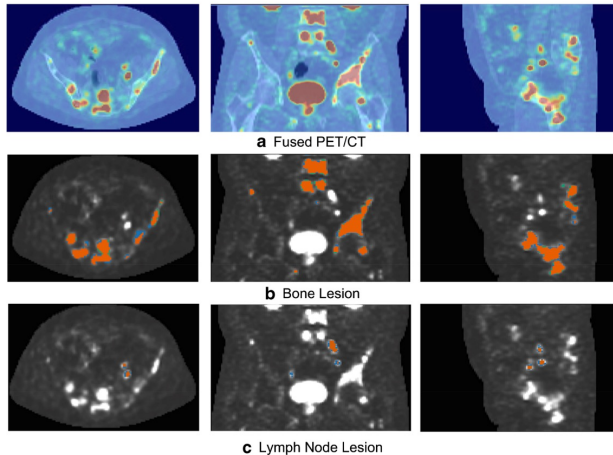
- Pazienti pediatrici



Wang et al. EJNMMI, 2021

## Assisted Interpretation

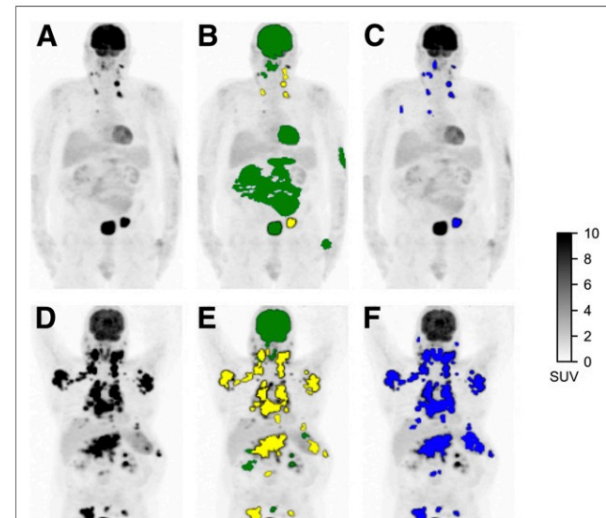
- Detection e segmentazione automatica



|           | Bone lesion | Lymph node lesion | Local lesion |
|-----------|-------------|-------------------|--------------|
| Precision | 0.99        | 0.94              | 0.79         |
| Recall    | 0.99        | 0.90              | 0.61         |
| F1 score  | 0.99        | 0.92              | 0.69         |

Zhao et al. Eur J Nucl Med Mol Imaging, 2020

- Rilevazione di biomarker metabolici (TMTV, parametri cinetici, etc)



**TRANSLATION INTO CLINICAL REALITY!**

Capobianco et al. J Nucl Med., 2021

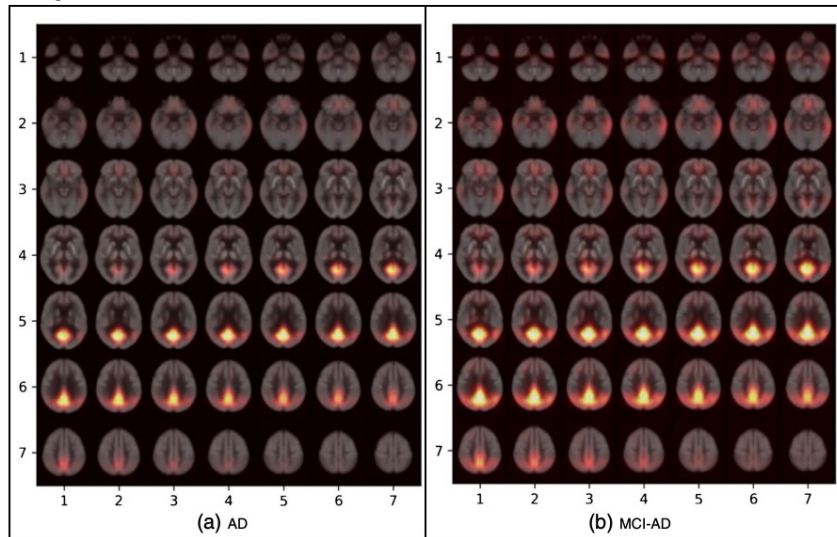
## Assisted Interpretation = Diagnosis assistance

European Journal of Nuclear Medicine and Molecular Imaging (2022) 49:563–584  
<https://doi.org/10.1007/s00259-021-05483-0>

ORIGINAL ARTICLE

A 3D deep learning model to predict the diagnosis of dementia with Lewy bodies, Alzheimer's disease, and mild cognitive impairment using brain 18F-FDG PET

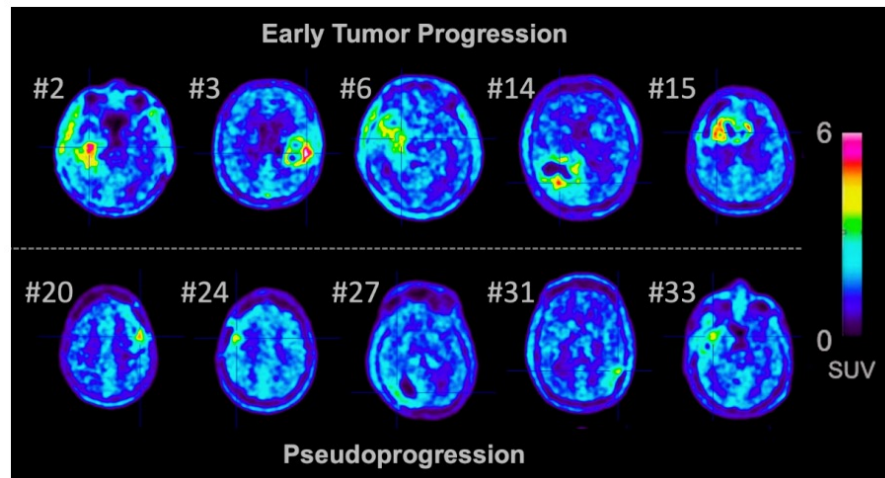
Etminani et al, 2022



Article

FET PET Radiomics for Differentiating Pseudoprogression from Early Tumor Progression in Glioma Patients Post-Chemoradiation

Lohmann et al, 2019





## Assisted Interpretation = Dosimetry

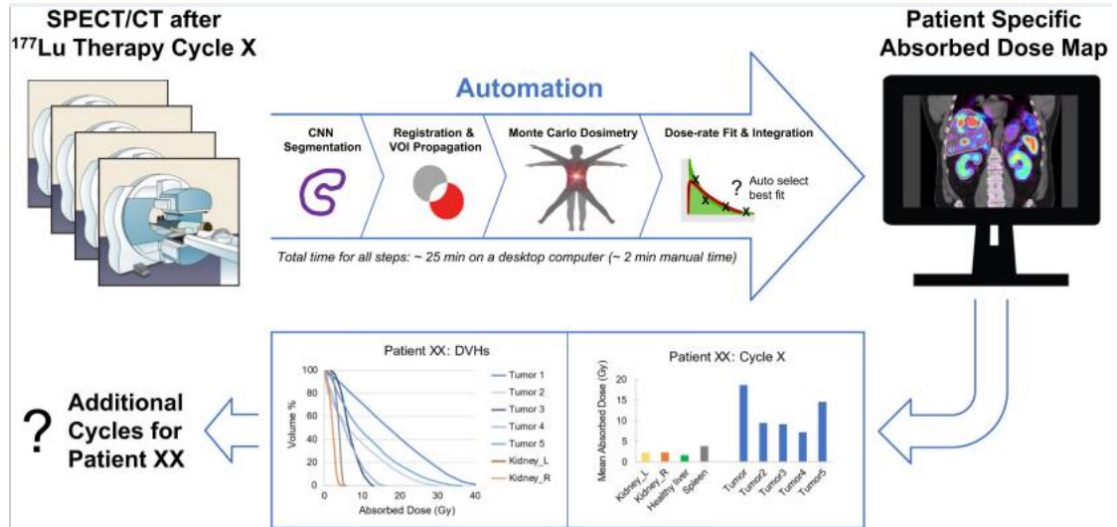
**JNM** The Journal of  
NUCLEAR MEDICINE

J Nucl Med. 2022 Nov; 63(11): 1665-1672.  
doi: [10.2967/jnumed.121.263738](https://doi.org/10.2967/jnumed.121.263738)

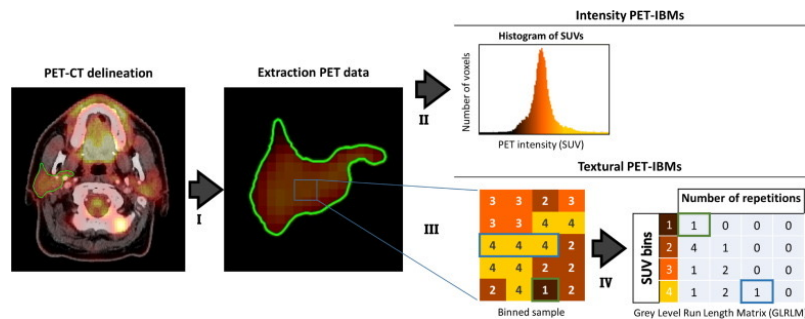
PMCID: PMC9635679  
PMID: [35422445](https://pubmed.ncbi.nlm.nih.gov/35422445/)

A Pipeline for Automated Voxel Dosimetry: Application in Patients with Multi-SPECT/CT Imaging After  $^{177}\text{Lu}$ -Peptide Receptor Radionuclide Therapy

Yuni K. Dewaraja,<sup>3,1</sup> David M. Mirando,<sup>2</sup> Avery B. Peterson,<sup>1,3</sup> Jeremy Niedbala,<sup>1</sup> John D. Millet,<sup>1</sup> Justin K. Mikell,<sup>4</sup> Kirk A. Frey,<sup>1</sup> Ka Kit Wong,<sup>1</sup> Scott J. Wilderman,<sup>1</sup> and Aaron S. Nelson<sup>2</sup>



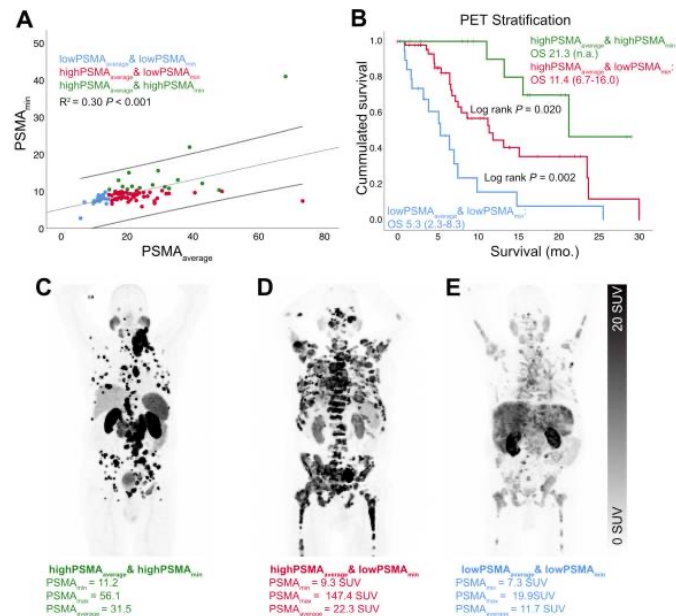
## Additional Insight



The FDG signatures model predicted the occurrence of xerostomia 12 months after radiotherapy, with an AUC of 0.77 in 161 head and neck carcinoma patients

van Dijk et al. Radiother. Oncol., 2018

## PSMA uptake patterns profiling and PRLT response prediction



Seifert et al. Theranostics, 2020

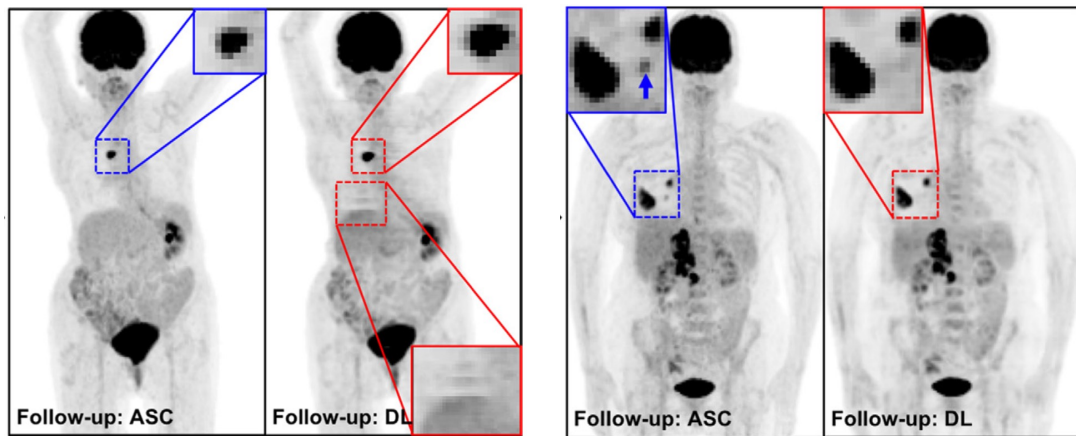
Not perfect?!



## CT-less Direct Correction of Attenuation and Scatter in the Image Space Using Deep Learning for Whole-Body FDG PET: Potential Benefits and Pitfalls

*Jaewon Yang, PhD • Jae Ho Sohn, MD, MS • Spencer C. Behr, MD • Grant T. Gillberg, PhD • Youngho Seo, PhD*

From the Department of Radiology and Biomedical Imaging (J.Y., J.H.S., S.C.B., G.T.G., Y.S.) and Physics Research Laboratory (J.Y., G.T.G., Y.S.), University of California, San Francisco, 185 Berry St, Suite 350, San Francisco, CA 94143-0946. Received June 4, 2020; revision requested July 2; revision received November 4; accepted November 13. Address correspondence to J.Y. (e-mail: jaewon.yang@ucsf.edu).



➤ AI-based reconstruction pitfalls

➤ AI-based denoising pitfalls

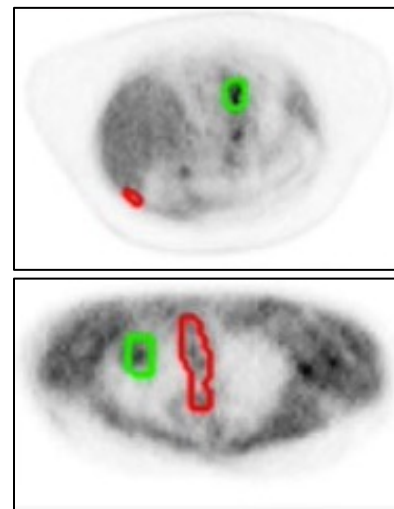
## Radioterapia Oncologica: l'evoluzione al servizio dei pazienti

### A physics-guided modular deep-learning based automated framework for tumor segmentation in PET

Kevin H Leung<sup>1,2</sup> , Wael Marashdeh<sup>3</sup>, Rick Wray<sup>4</sup>, Saeed Ashrafinia<sup>2,5</sup>, Martin G Pomper<sup>1,2</sup>, Arman Rahmim<sup>2,6</sup>  and Abhinav K Jha<sup>7</sup> 

Published 9 December 2020 • © 2020 Institute of Physics and Engineering in Medicine

[Physics in Medicine & Biology, Volume 65, Number 24](#)



➤ AI-based lesion segmentation pitfalls



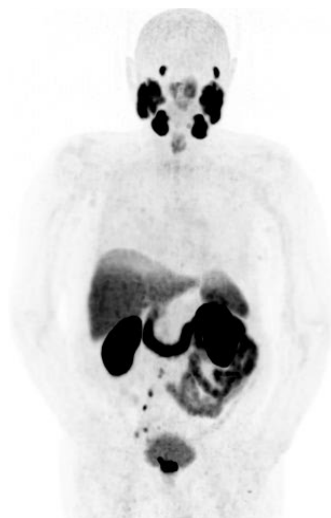
### Accelerated Imaging Integration

G

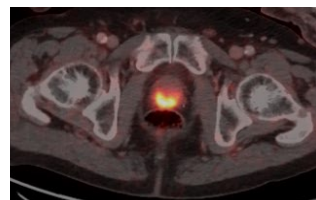
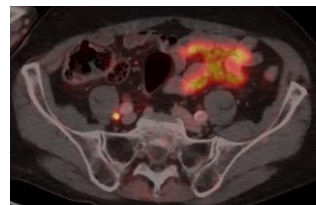
Hello. Could you please write a 68Ga-PSMA PET/CT report for a patient with suspected prostate cancer progression?  
The scan shows a diffuse uptake in the primary tumor and the involvement of iliac/obturator lymph nodes.



Certainly! Here's a sample 68Ga-PSMA PET/CT report for a patient with suspected prostate cancer progression:



<sup>68</sup>Ga-PSMA-11 PET/CT



#### DISCUSSIONS WITH LEADERS

### Nuclear Medicine from a Novel Perspective: Buvat and Weber Talk with OpenAI's ChatGPT

Irène Buvat, PhD<sup>1</sup>, and Wolfgang Weber, MD, PhD<sup>2</sup>

<sup>1</sup>Inserm Laboratory of Translational Imaging in Oncology, Institut Curie, Orsay, France; <sup>2</sup>University Hospital, Technische Universität München, Munich, Germany

[Hospital/Imaging Center Letterhead]

68Ga-PSMA PET/CT Imaging Report

Patient Information:

- **Name:** [Patient's Full Name]
- **Date of Birth:** [Patient's Date of Birth]
- **Medical Record Number:** [Patient's MRN]
- **Referring Physician:** [Referring Physician's Name]
- **Date of Study:** [Date of Imaging Study]

**Clinical History:** The patient is a [age]-year-old male with a history of prostate cancer, status post [relevant treatments/surgeries], who is being evaluated for suspected prostate cancer progression.

**Imaging Findings:** The 68Ga-PSMA PET/CT was performed for the evaluation of suspected prostate cancer progression.

**PET/CT Protocol:** A whole-body 68Ga-PSMA PET/CT scan was performed from the vertex to the mid-thighs.

**PET/CT Findings:** The 68Ga-PSMA PET/CT scan demonstrates the following findings:

1. **Primary Tumor:** There is intense and diffuse radiotracer uptake in the region of the prostate gland, consistent with the primary tumor. The standardized uptake value (SUV<sub>max</sub>) at this site is [SUV<sub>max</sub> value].
2. **Lymph Node Involvement:** Increased 68Ga-PSMA uptake is observed in the iliac and obturator lymph nodes bilaterally. The SUV<sub>max</sub> values for the lymph nodes are as follows: [SUV<sub>max</sub> values for individual lymph nodes]. These findings are highly suspicious for metastatic involvement.
3. **Other Sites:** No other significant areas of abnormal 68Ga-PSMA uptake are identified in the rest of the body, indicating no evidence of distant metastases.

**Impression:** The 68Ga-PSMA PET/CT scan demonstrates intense radiotracer uptake within the primary prostate tumor and metastatic involvement of the iliac and obturator lymph nodes bilaterally. These findings are highly suggestive of prostate cancer progression with lymph node metastases. No evidence of distant metastases is identified on this scan.

**Clinical Correlation:** Clinical and histopathological correlation is recommended to further characterize the extent of disease and guide treatment planning.

**Recommendations:**

1. Consultation with the referring urologist or oncologist for further management and to discuss potential treatment options.
2. Biopsy or additional imaging studies, such as MRI, may be considered to confirm and characterize the extent of disease in the prostate and regional lymph nodes.

**Reporting Radiologist:** [Your Name] [Your Credentials] [Date of Report]

Clinical and Translational Imaging (2023) 11:407–411  
<https://doi.org/10.1007/s40336-023-00574-4>

## SPOTLIGHT

## ChatGPT in nuclear medicine and radiology: lights and shadows in the AI bionetwork

Riccardo Laudicella<sup>1</sup> · Guido A. Davidzon<sup>2</sup> · Nikolaos Dimos<sup>3</sup> · Gaetano Provenzano<sup>4</sup> · Andrei Iagaru<sup>5</sup> · Sotirios Bisdas<sup>5,6</sup>



Caution!



**Table 1** An example of a conversation with ChatGPT including inaccuracies

Authors' query (R.L. on the 12.03.2023): In a patient with biochemical recurrence from operated prostate cancer and PSA of 1 ng/ml, would you recommend choline or PSMA PET?

ChatGPT's reply: The choice between choline PET and PSMA PET depends on the patient's specific condition and medical history. In general, PSMA PET has been shown to have higher sensitivity and specificity than choline PET in detecting prostate cancer tissue with low PSA levels, such as in the case of biochemical recurrence. However, in some cases choline PET may still be an appropriate choice, such as if the patient has a history of low-grade prostate cancer or if PSMA PET is not available. Thus, in the specific case of a patient with biochemical recurrence from operated prostate cancer and PSA of 1 ng/ml, it might be appropriate to perform a PSMA PET scan as it has a higher sensitivity in detecting prostate cancer tissue at low PSA levels. However, the final decision should be made by the treating physician after careful evaluation of the patient's medical history and specific information on the availability of different diagnostic technologies. However, it is important to note that PET scans can involve some complications, such as allergic reactions or drug interactions, and can be expensive. Therefore, it is important to discuss the risks and benefits of the procedure with your physician before deciding to undergo a PET scan

Authors' query: In PET scans, we do not use contrast agents but radiopharmaceuticals; allergic reactions and drug interactions are very rare and minimal, differently from those of contrast media

ChatGPT's reply: You are right, I apologize for the error in my previous response. PET scans use a radiotracer and not a contrast agent, so allergic reactions are not a risk associated with this type of procedure. The radiotracer used in PET is a radioactive compound that is administered to the patient, often intravenously, and accumulates in body tissues. Once the radiotracer has accumulated in the target tissues, patients undergo a PET scan, which detects the radiation emitted by the radiotracer and creates a three-dimensional image of the tissues. It is important to note

to discuss the risks and benefits of the procedure with your physician before deciding to undergo a PET scan

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Hi Giulia Santol Welcome back 🍌

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### Artificial Intelligence and Radiomics Applications in Neuro-endocrine Neoplasms (NENs): New Tools for Molecular Hybrid Imaging and Theragnostics Approaches

09 Jun 2023 -

**TL;DR:** In this article, the authors describe the state-of-the-art on AI and radiomics applications in molecular imaging of neuroendocrine neoplasms (NENs).

[View 10 related papers >](#)

**Abstract:** In neuroendocrine neoplasms (NENs), the use of new radiopharmaceuticals has improved the accuracy of diagnosis and staging, refined surveillance approaches, and introduced specific and personalized radiation therapies. Nuclear medicine has therefore acquired a crucial role in the management of NENs patients by improving their risk stratification and personalized therapies. Artificial intelligence (AI) and radiomics can enable physicians to further improve the overall efficiency and accuracy of the use of these tools in both c...read more












English (en) ▾

(NENs): New Tools for Molecular Hybrid Imaging and Theragnostics Approaches

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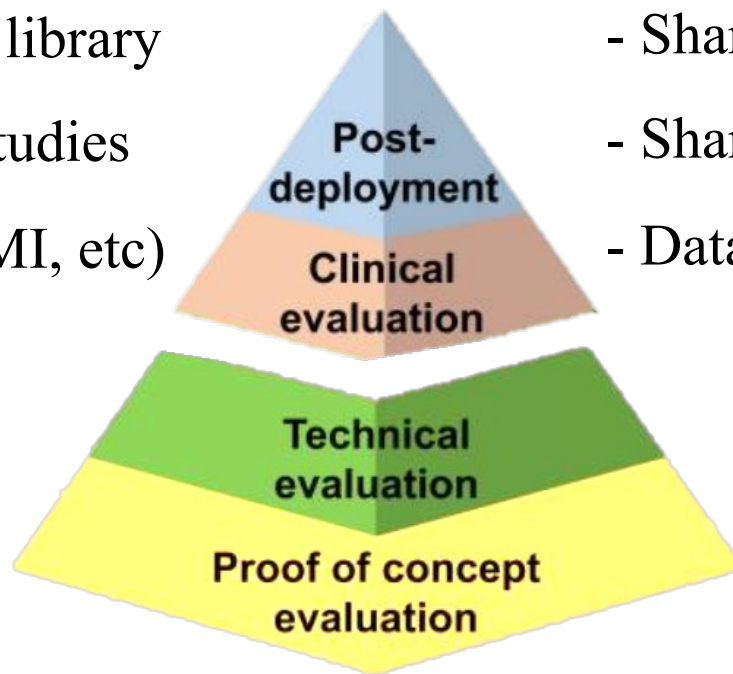
- The use of new radiopharmaceuticals has improved the accuracy of diagnosis and staging, refined surveillance approaches, and introduced specific and personalized radiation therapies. Nuclear medicine has therefore acquired a crucial role in the management of NENs patients by improving their risk stratification and personalized therapies.
- Nuclear medicine has therefore acquired a crucial role in the management of NENs patients by improving their risk stratification and personalized therapies. Artificial intelligence (AI) and radiomics can enable physicians to further improve the overall efficiency and accuracy of the use of these tools in both diagnostic and therapeutic settings.
- Artificial intelligence (AI) and radiomics can enable physicians to further improve the overall efficiency and accuracy of the use of these tools in both diagnostic and therapeutic settings.
- AI and radiomics can improve the prediction of tumor grade, differential diagnosis from other malignancies, assessment of tumor behavior and aggressiveness, and prediction of treatment response in NENs.
- The paper aims to describe the state-of-the-art on AI and radiomics applications in molecular imaging of NENs [1].



Write your question...

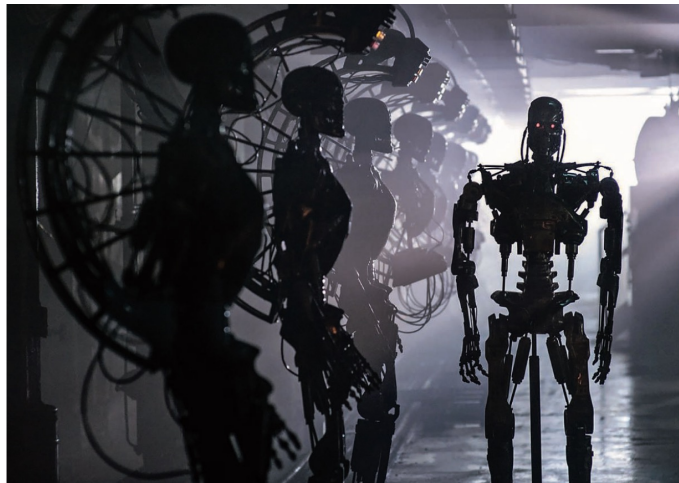


- AI-algorithms and library
- Proof of concept studies
- Guidelines (SNMMI, etc)



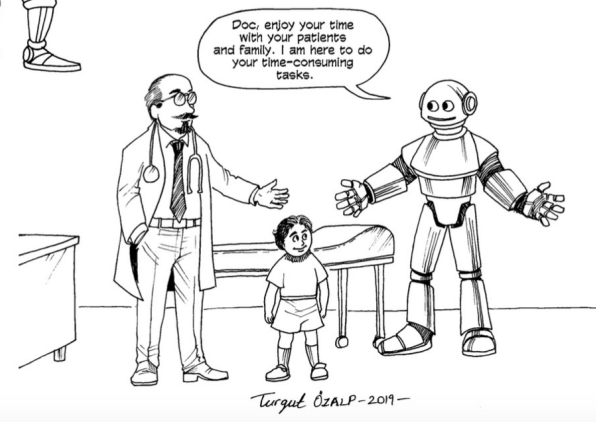
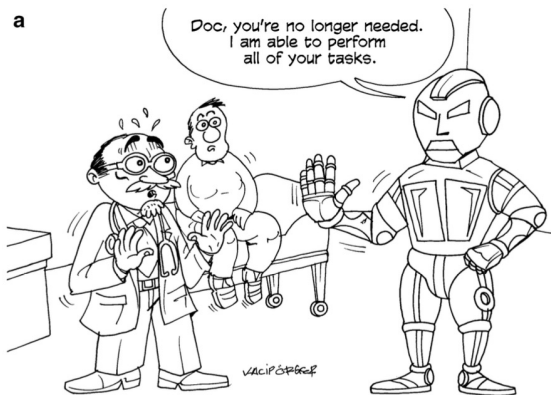
- Sharing data and results
- Sharing models and knowledge
- Data protection regulations

Jha et al. J Nucl Med, 2022



## Fears of an AI pioneer

John Bohannon  
*Science*, 2015



Cumali Aktolun Eur J Nucl Med Mol Imaging, 2019



*Grazie*