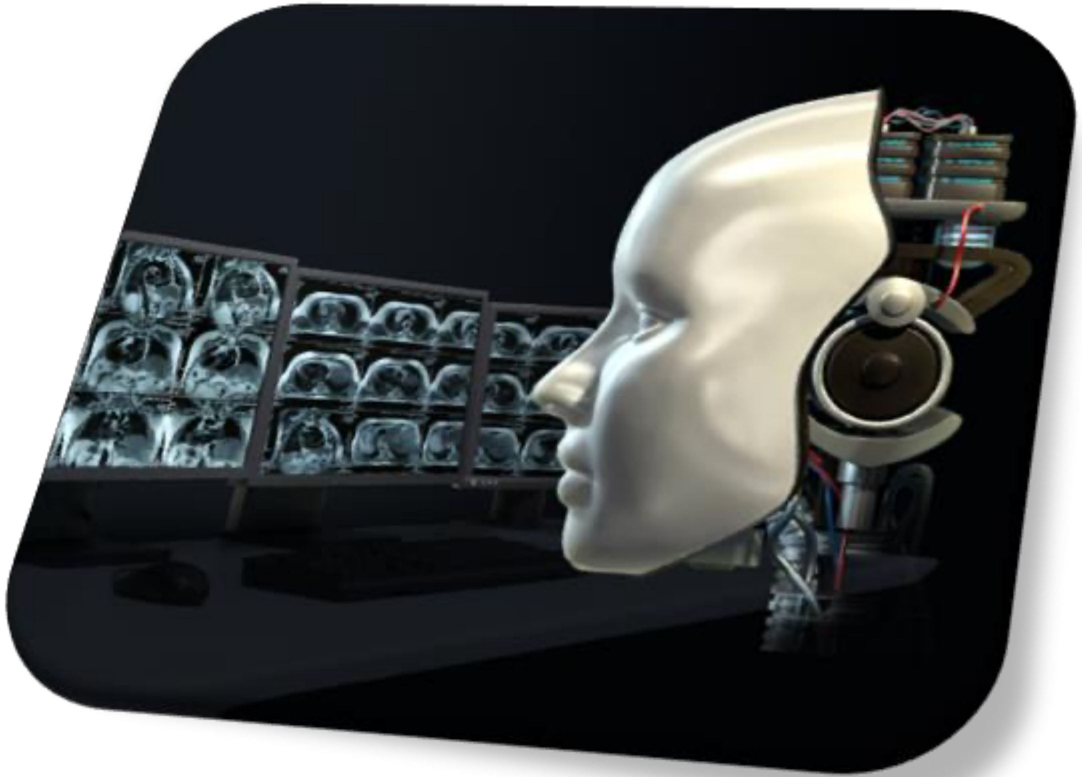
AI predittiva in radiologia oncologica



Nicoletta Gandolfo
Francesca Rosa

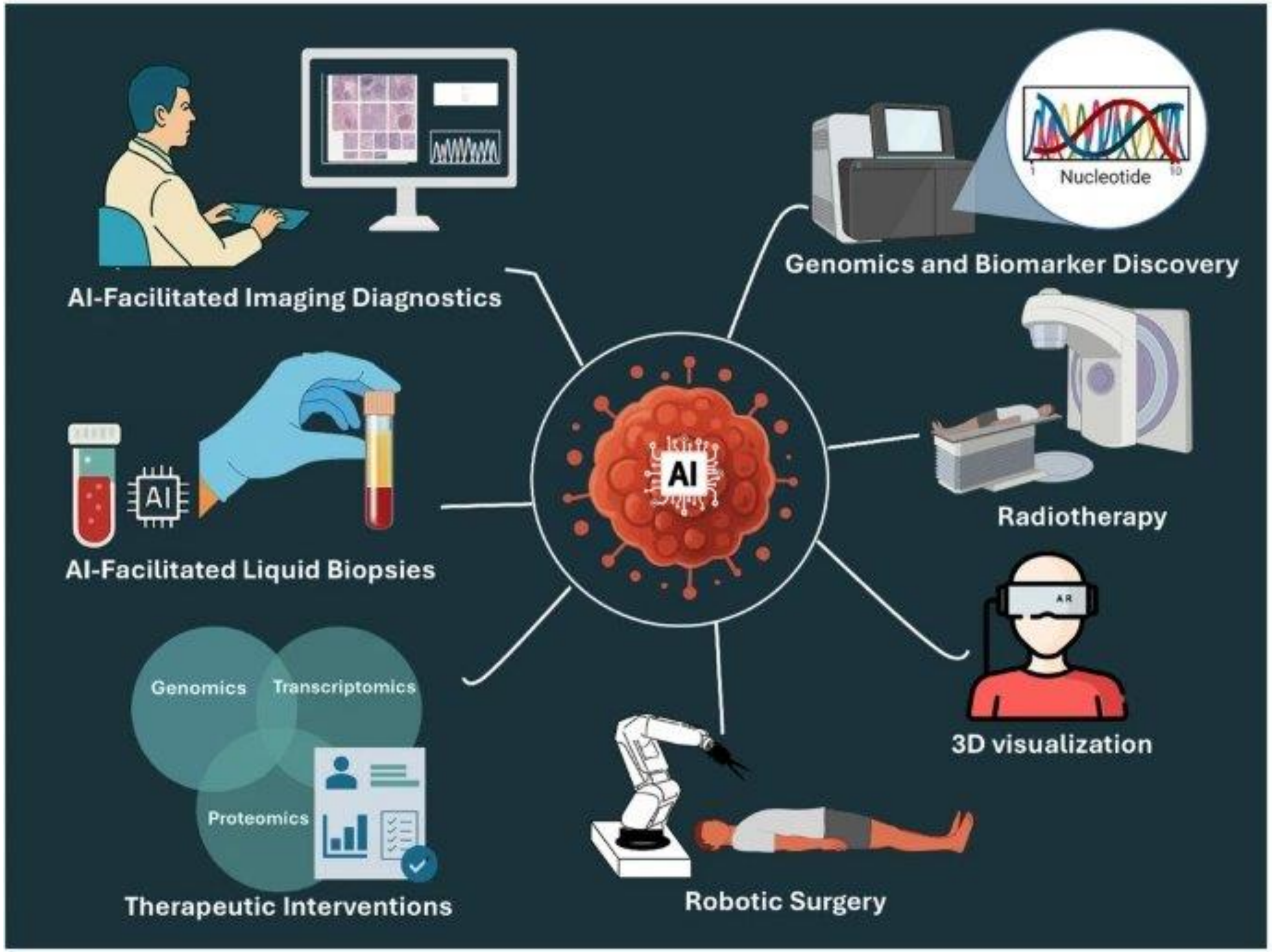
Asl3 Sistema Sanitario Regione Liguria
Asl2 Sistema Sanitario Regione Liguria

Review | Open access | Published: 02 June 2025

Current AI technologies in cancer diagnostics and treatment

Ashutosh Tiwari, Soumya Mishra & Tsung-Rong Kuo

Molecular Cancer **24**, Article number: 159 (2025) | Cite this article

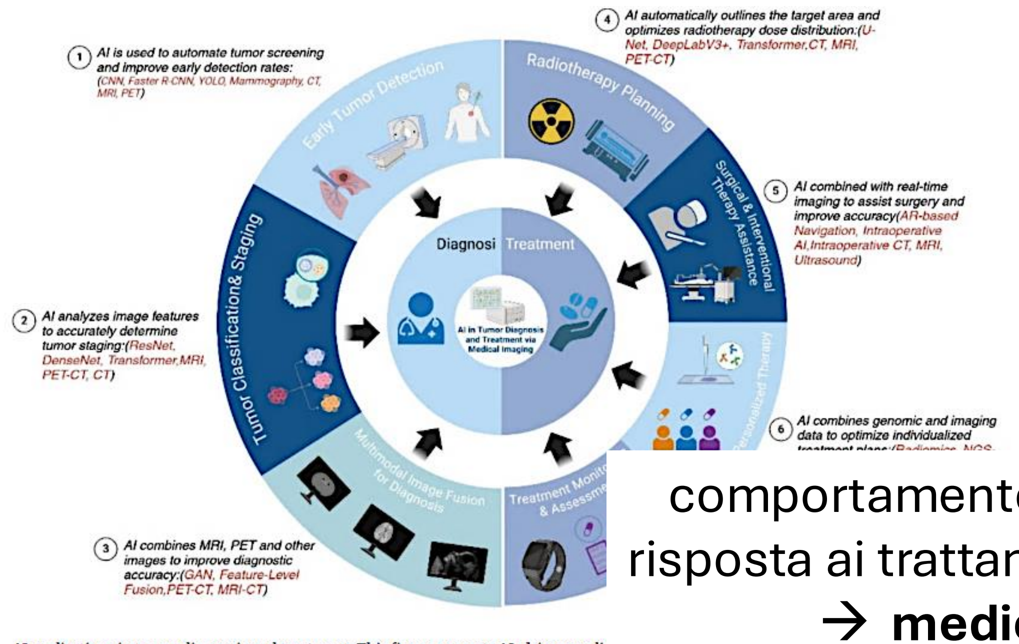


- → **potenziare** la diagnosi precoce
- → **prevedere** gli esiti dei trattamenti,
- → **identificare** nuovi bersagli farmacologici;
- → **stratificare** i pazienti per un'assistenza personalizzata

Home > Discover Oncology > Article

Application of artificial intelligence in medical imaging for tumor diagnosis and treatment: a comprehensive approach

Review | Open access | Published: 26 August 2025
Volume 16, article number 1625, (2025) Cite this article
Discover Oncology



AI applications in tumor diagnosis and treatment. This figure presents AI-driven appli
medical imaging. (1) Early Tumor detection;(2) Tumor classification & staging;(3) Mul
planning;(5) Surgical & Interventional therapy assistance;(6) Targeted & Personalized

European Journal of Radiology Open 9 (2022) 100441
Contents lists available at ScienceDirect
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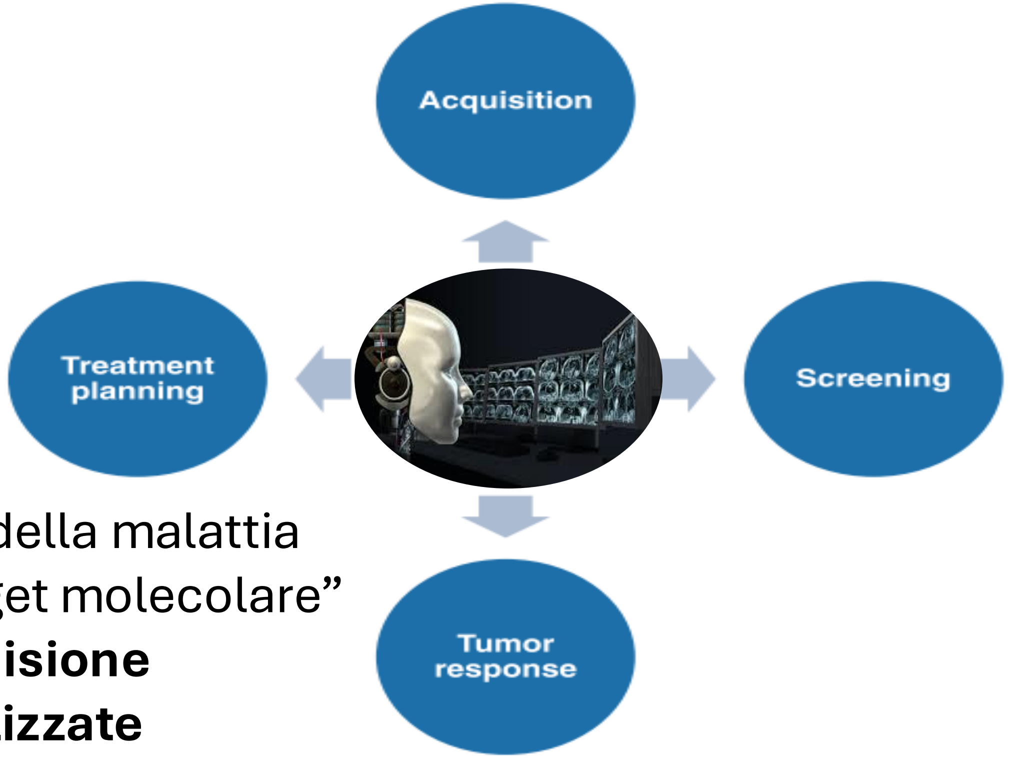
Artificial intelligence in oncologic imaging

Melissa M. Chen [a,*], Admir Terzic [b], Anton S. Becker [c], Jason M. Johnson [a], Carol C. Wu [d], Max Wintermark [a], Christoph Wald [e], Jia Wu [f]



comportamento biologico della malattia
risposta ai trattamenti a "target molecolare"
→ **medicina di precisione**
→ **terapie personalizzate**

European Journal of Radiology Open 9 (2022) 100441
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Artificial intelligence in oncologic imaging

Melissa M. Chen[a,*], Admir Terzic[b], Anton S. Becker[c], Jason M. Johnson[a], Carol C. Wu[d], Max Wintermark[a], Christoph Wald[e], Jia Wu[f]

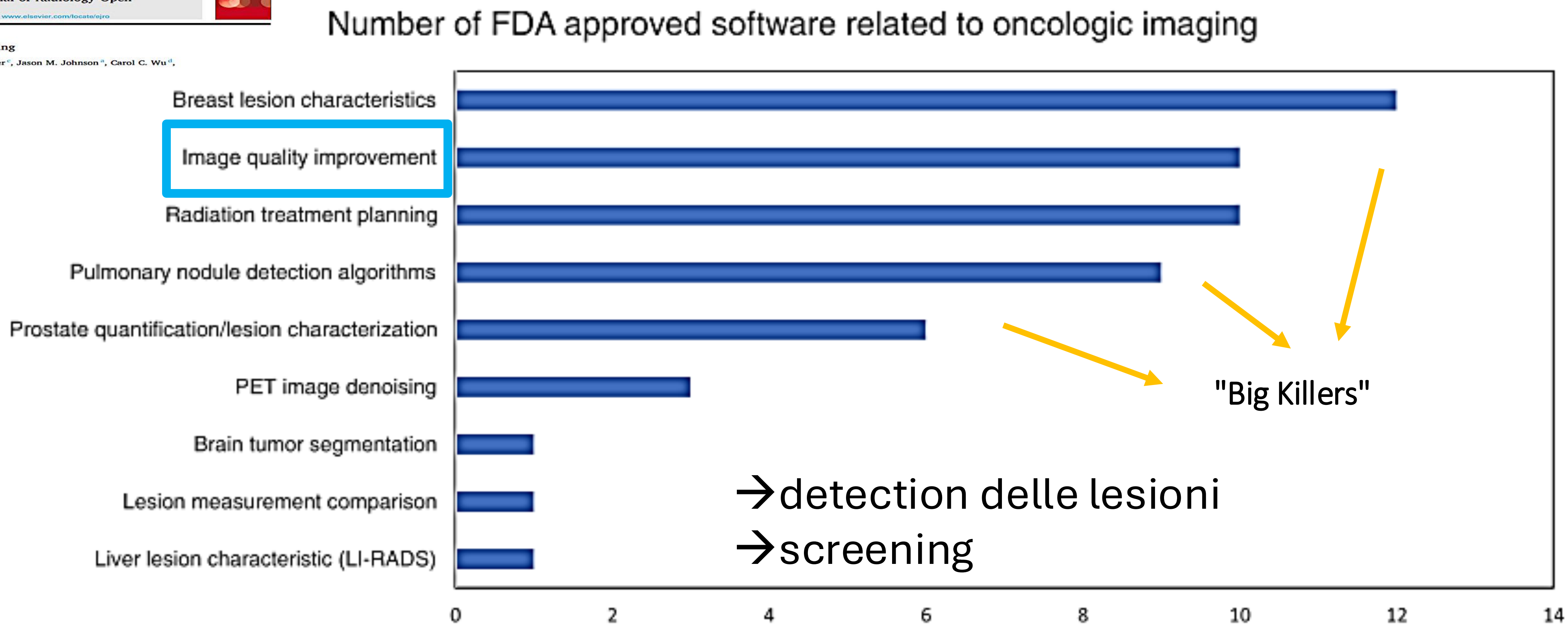


Fig. 3. FDA-Approved AI software related to oncologic imaging from the ACR Data Science Institute Database.

quali di queste applicazioni sono già realtà nella pratica clinica e quali ancora in corso di studio ?

"Vi sono due maniere di scrivere sul futuro: una scientifica ed un'altra utopistica"

Bertrand Russell, filosofo e matematico

Realtà

Ottimizzazione dell’acquisizione

1. Protocollo di acquisizione ottimizzato (AI-driven protocoling)

•Selezione automatica del protocollo TC/MRI in base alla richiesta

•Adattamento dei parametri (kV, mAs, pitch, FOV).

2. Riduzione della dose (CT / PET)

•Algoritmi di ricostruzione AI-based per garantire la **stessa qualità** con **minore dose**.

3. Accelerazione dell’acquisizione MRI

•Riduzione significativa dei tempi di scansione (fino al 50–70%).

•Maggiore comfort per il paziente e meno artefatti da movimento.

4. Correzione degli artefatti

•Riduzione artefatti (movimento, protesi metalliche)

Ottimizzazione del workflow

1. Triaging automatico delle immagini

•Identificazione immediata di casi positivi (es mmx).

•Prioritizzazione automatica nella worklist.

2. Segmentazione automatica degli organi e delle lesioni

•Contorni automatici per:

- tumori
- organi a rischio (RT)
- Risparmio di tempo per Radiologi, Radioterapisti.

3. Supporto alla diagnosi

•Suggerimento preliminare di findings.

•Evidenziazione automatica di anomalie (cad).

•Riduzione degli errori di omissione.

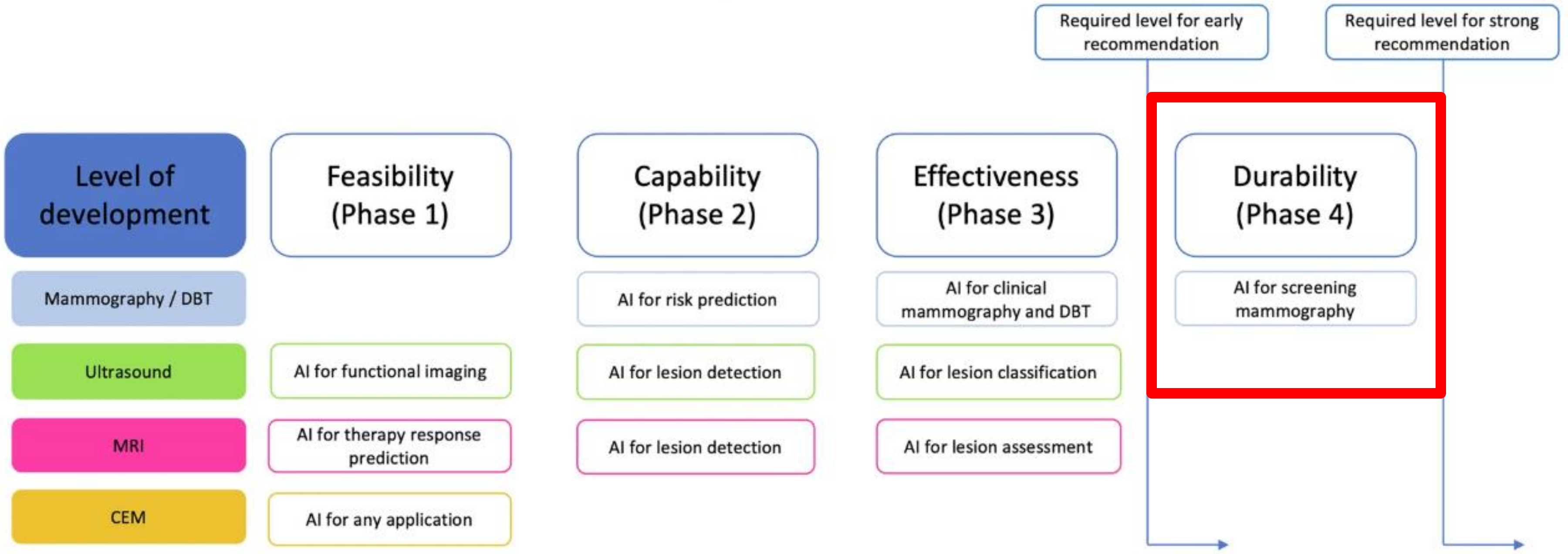
4. Ricerca e confronto automatico di immagini precedenti

5. compilazione di referto strutturato

AI in senologia

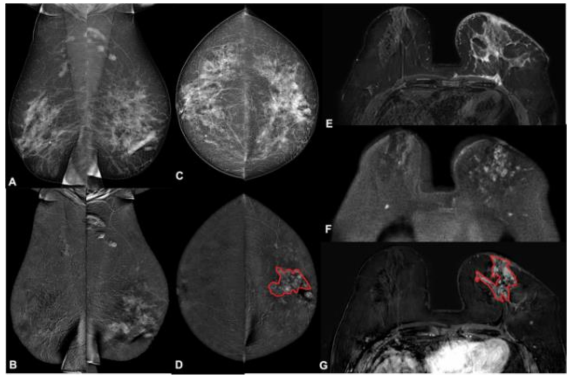
Review > Eur Radiol. 2025 Aug 26. doi: 10.1007/s00330-025-11954-x. Online ahead of print.

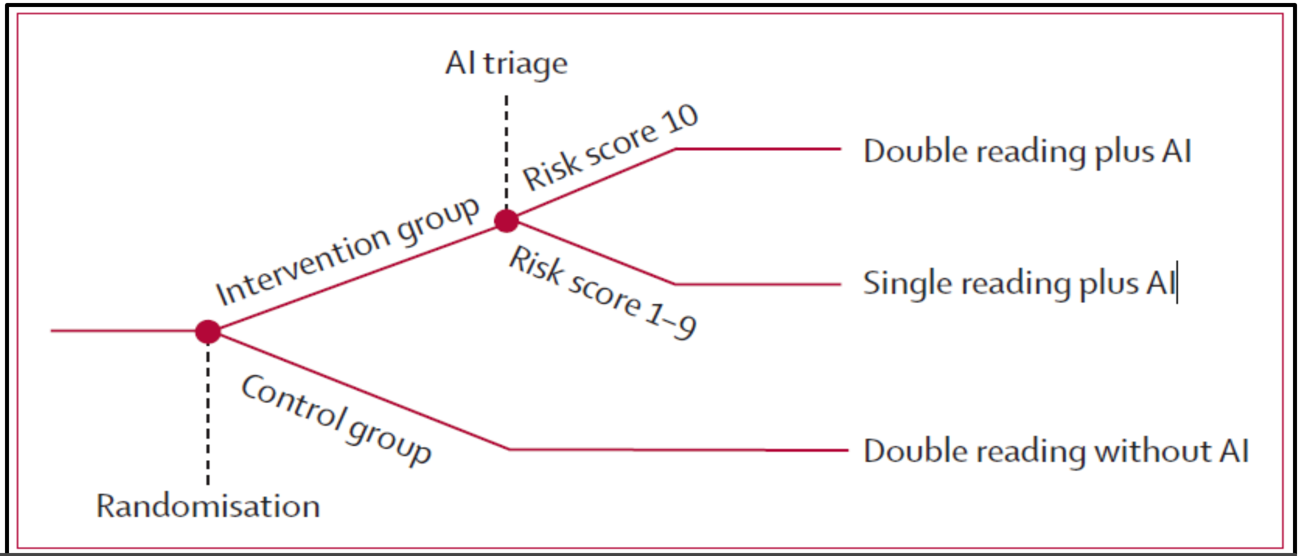
ESR Essentials: artificial intelligence in breast imaging-practice recommendations by the European Society of Breast Imaging

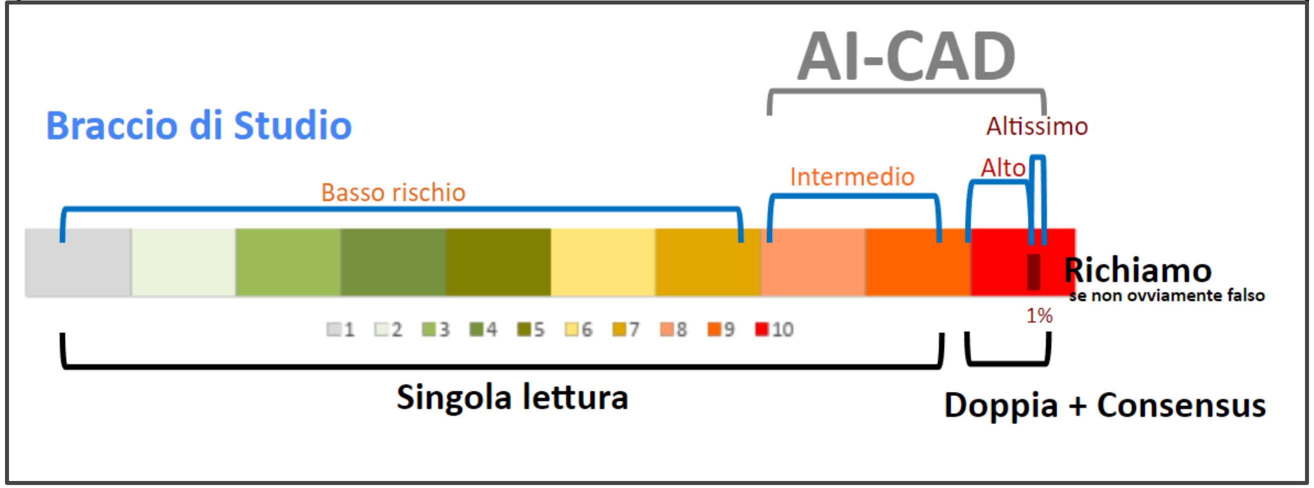


Imaging modality	Main available evidence	Future perspectives
Screening digital mammography	• Enhanced diagnostic performance, even in prospective randomized studies • Significant workload reduction • Better risk assessment than traditional models	• Extensive external validation studies • Assessment of potential impact on long-term outcomes • Post-marketing surveillance
Digital breast tomosynthesis	• Significant reading time reduction • Optimized workflows • High accuracy, especially in dense breasts	• Validation on large-scale prospective studies • Assessment of potential impact on long-term outcomes • Further integration across vendor systems
Breast ultrasound	• Improved lesion characterization • Reduce unnecessary biopsies • Integration with elastography • Good performance in axillary staging	• Standardize guidelines • Triaging in resource-limited environments • Neoadjuvant therapy response prediction
Breast MRI screening	• Limited value of commercial CAD tools • Preliminary studies on screening sets • Limited diagnostic performance in real screening cohorts	• Validation in real screening cohorts • Workload reduction
Breast MRI advanced applications	• Promising results in recurrence scores and risk prediction • Good performance on molecular subtyping prediction • Improved neoadjuvant therapy response prediction	Personalized screening based on risk prediction Neoadjuvant treatment tuning Development of contrast-free imaging
Contrast-enhanced mammography	• Radiomics-based molecular subtype classification • Promising synthetic image generation	External validation studies Development of reduced-contrast or contrast-free techniques

OBIETTIVI
AI predittiva in radiologia Senologica







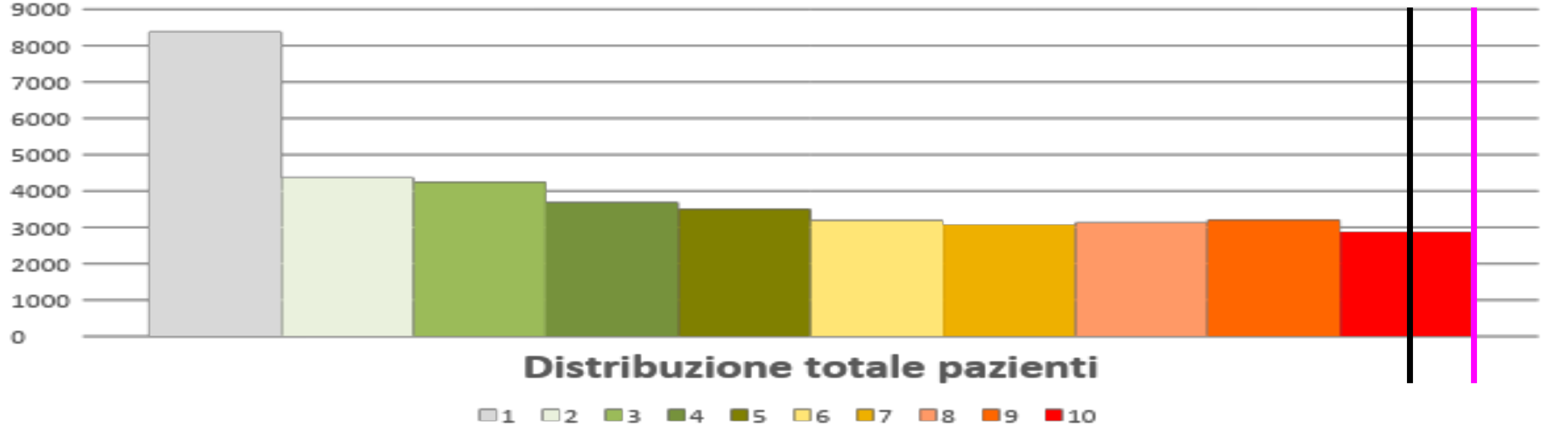
Artificial intelligence-supported screen reading versus standard double reading in the Mammography Screening with Artificial Intelligence trial (MASAI): a clinical safety analysis of a randomised, controlled, non-inferiority, single-blinded, screening accuracy study

Kristina Lång, Viktoria Josefsson, Anna-Maria Larsson, Stefan Larsson, Charlotte Högberg, Hanna Sartor, Solveig Hofvind, Ingvar Andersson, Aldana Rosso

STUDIO MASAI: lo screening mammografico supportato dall'IA può essere considerato **sicuro**:

- Score 1-9 **92% di tutti gli esami** singola lettura
- Score 10 **8% di tutti gli esami** con un 1,2% score altissimo

Score *Altissimo*: DR 277.6‰
RR 38.6% - VPP 72%



Score 1-7 DR 0.2‰ **Score 8-9 DR 4.7‰** **Score Alto DR 72.3‰**

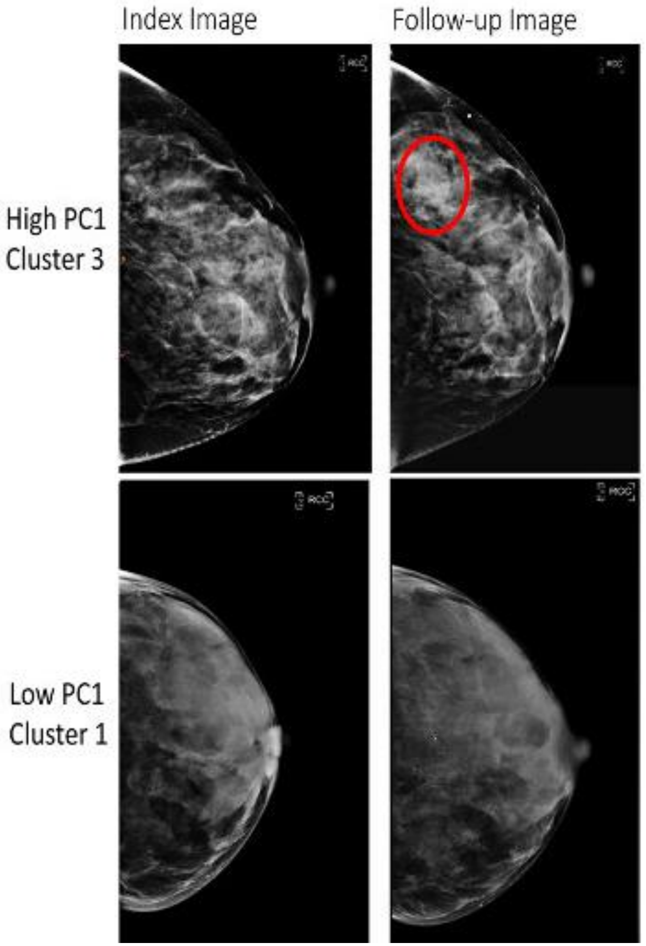
- DR > limite più basso accettabile per la sicurezza (> 3 °/00)
- = tassi di richiamo, falsi positivi o il ricorso consensus
- < carico di lavoro del 30 % e concentra le forze sui casi con alto score (dove erano concentrati la maggior parte di cancri)

«Predire» il rischio di sviluppare il cancro

Radiology. 2025 May;315(2):e240281. doi: 10.1148/radiol.240281.

Radiomic Parenchymal Phenotypes of Breast Texture from Mammography and Association with Risk of Breast Cancer

Stacey J Winham [1], Anne Marie McCarthy [2], Christopher G Scott [1], Aimilia Gastounioti [3], Hannah Horng [4], Aaron D Norman [1], Walter C Mankowski [4, 5], Lauren Pantalone [4], Matthew R Jensen [1], Raymond J Acciavatti [4], Andrew D A Maidment [4], Eric A Cohen [4, 5], Kathleen R Brandt [6], Emily F Conant [4], Karla M Kerlikowske [#, 7], Despina Kontos [#, 4, 5, 8], Celine M Vachon [#, 1]



«Predire» il rischio di sviluppare il cancro

JMRI
Journal of Magnetic Resonance Imaging
ISMRM
ONE COMMUNITY FOR CLINICIANS AND SCIENTISTS

Original Research

Machine learning-based prediction of future breast cancer using algorithmically measured background parenchymal enhancement on high-risk screening MRI

Ashirbani Saha PhD, Lars J. Grimm MD, Sujata V. Ghate MD, Connie E. Kim MD, Mary S. Soo MD, Sora C. Yoon MD, Maciej A. Mazurowski PhD

First published: 16 January 2019 | https://doi.org/10.1002/jmri.26636 | Citations: 31

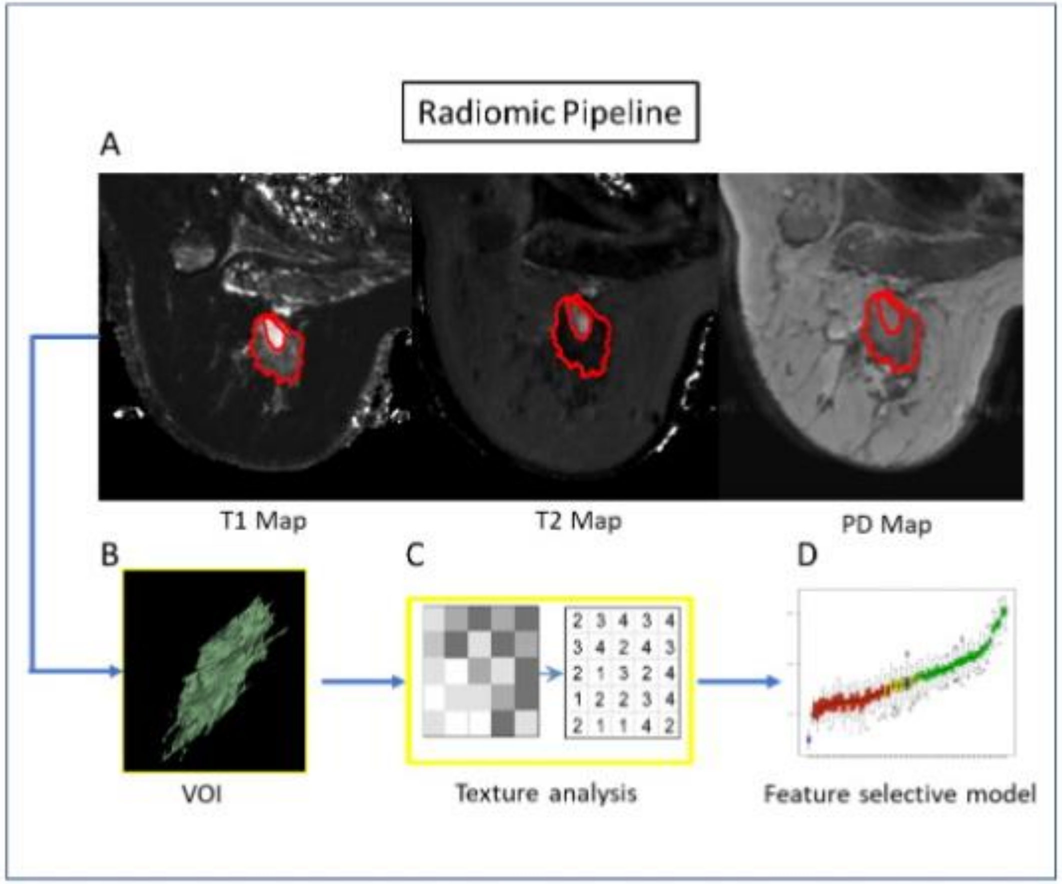
Background parenchymal enhancement (BPE) features to **predict cancer onset within 2 years**

A Radiomics Model Based on Synthetic MRI for Predicting Neoadjuvant Systemic Treatment Response in Triple-Negative Breast Cancer

«Predire» la risposta al trattamento

Radiomic analysis was applied to quantitative T1, T2, and proton density maps acquired with synthetic MRI to differentiate participants with and without pathologic complete response.

A multivariable radiomic model from T1 maps at mid-treatment predicted pathologic complete response with AUCs of 0.78 and 0.72 in training and testing cohorts, respectively.



Hwang KP et al. Published Online: July 28, 2023
DOI: https://doi.org/10.1148/rycan.230009

AI e tumore polmonare

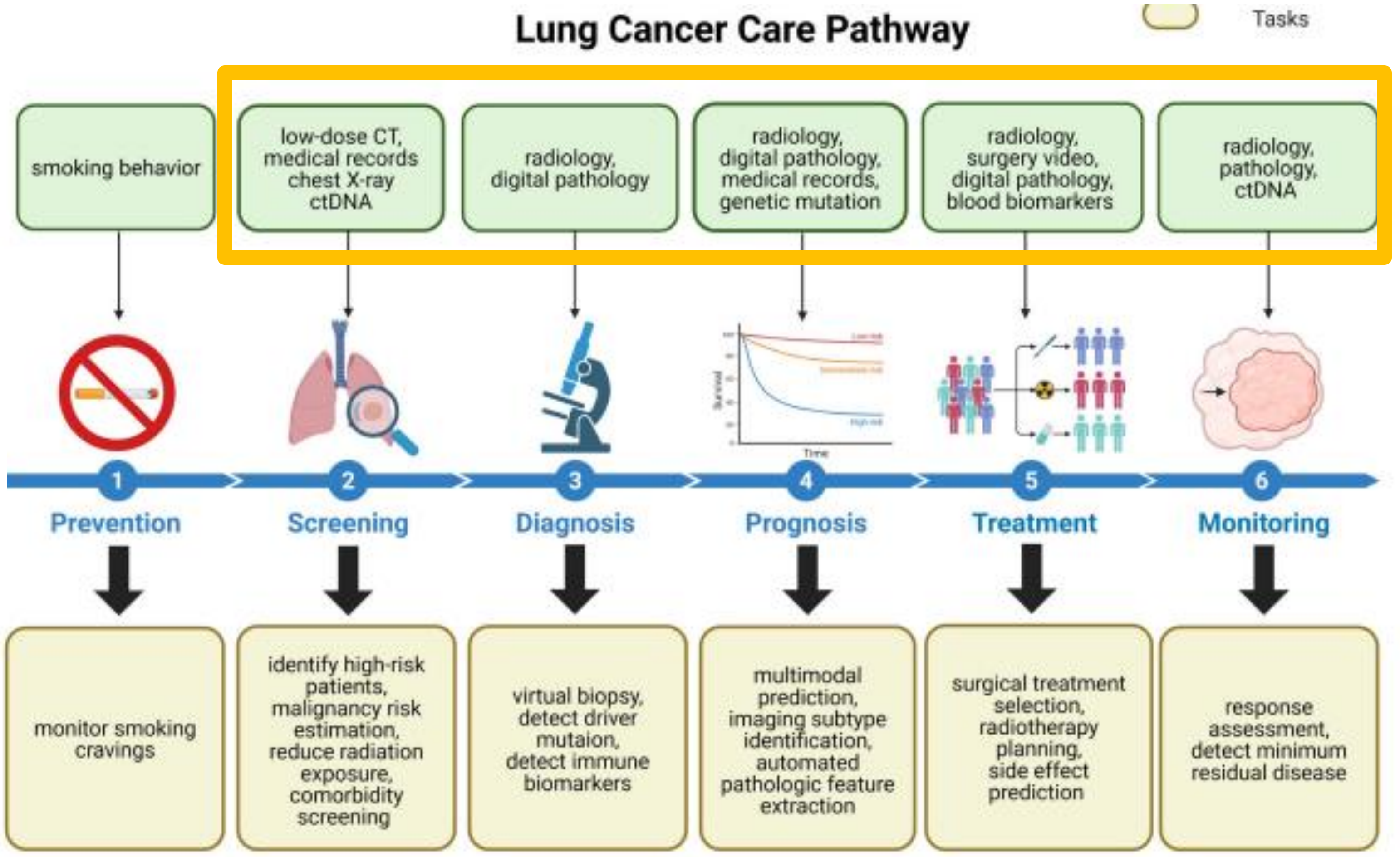
nature > npj precision oncology > review > article

Review | Open access | Published: 01 July 2025

Progress and challenges of artificial intelligence in lung cancer clinical translation

Erjia Zhu, Amgad Muneer, Jianjun Zhang, Yang Xia, Xiaomeng Li, Caicun Zhou, John V. Heymach, Jia Wu & Xiuning Le

npj Precision Oncology 9, Article number: 210 (2025) | Cite this article



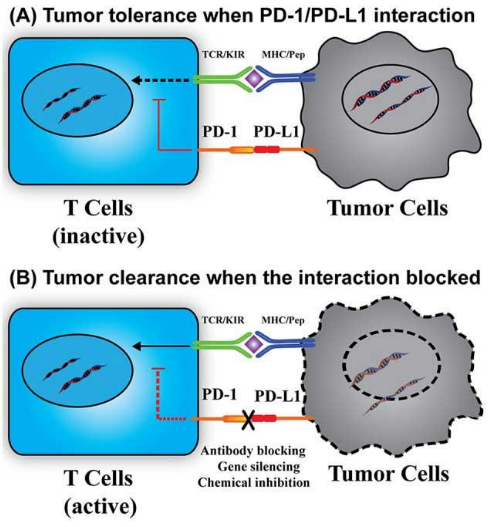
g. 1 | **AI applications in lung cancer care pathway.** Created in BioRender. Zhu, E. (2025) https://BioRender.com/f83y797.

- *Detection*
- *Caratterizzazione* (maligno vs benigno)
- *Segmentazione* → planning RT

FDA approved AI devices in lung cancer

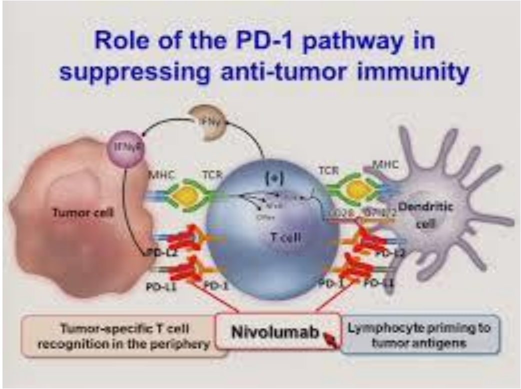
Data modality	Task	FDA summary	Year
CT	detection of pulmonary nodules in asymptomatic population	https://www.accessdata.fda.gov/cdrh_docs/pdf16/k161201.pdf	2016
CT, MRI	segmentation of lung nodules and liver lesions, automated reporting	https://www.accessdata.fda.gov/cdrh_docs/pdf17/K173542.pdf	2017
CT	characterization of nodule type, location, and measurements	https://www.accessdata.fda.gov/cdrh_docs/pdf16/K162484.pdf	2017
CT	segmentation of lesions of the lung, liver, and lymph nodes	https://www.accessdata.fda.gov/cdrh_docs/pdf18/K183271.pdf	2019
CT	characterization of nodule type, location, measurements, and Lung-RADS category	https://www.accessdata.fda.gov/cdrh_docs/pdf20/K201710.pdf	2020
CT	detection of solid pulmonary nodules, alerts to overlooked regions	https://www.accessdata.fda.gov/cdrh_docs/pdf20/K201501.pdf	2021
CT	quantitative analysis of lung nodule CT scanning. calculation the malignancy score	https://www.accessdata.fda.gov/cdrh_docs/pdf21/K214036.pdf	2022
CT	Detection of lung nodules	https://www.accessdata.fda.gov/cdrh_docs/pdf22/K221592.pdf	2023
PET/CT	Assess the fraction of total lung function for lung cancer resection	https://www.accessdata.fda.gov/cdrh_docs/pdf22/K221680.pdf	2023
PET and CT	detection of lung nodules	https://www.accessdata.fda.gov/cdrh_docs/pdf22/K223325.pdf	2023
CT	detection of solid pulmonary nodules, alerts to overlooked regions	https://www.accessdata.fda.gov/cdrh_docs/pdf23/K231157.pdf	2023
CT	radiotherapy treatments planning	https://www.accessdata.fda.gov/cdrh_docs/pdf22/K223724.pdf	2023

AI e Radiomica applicata e cancro polmonare

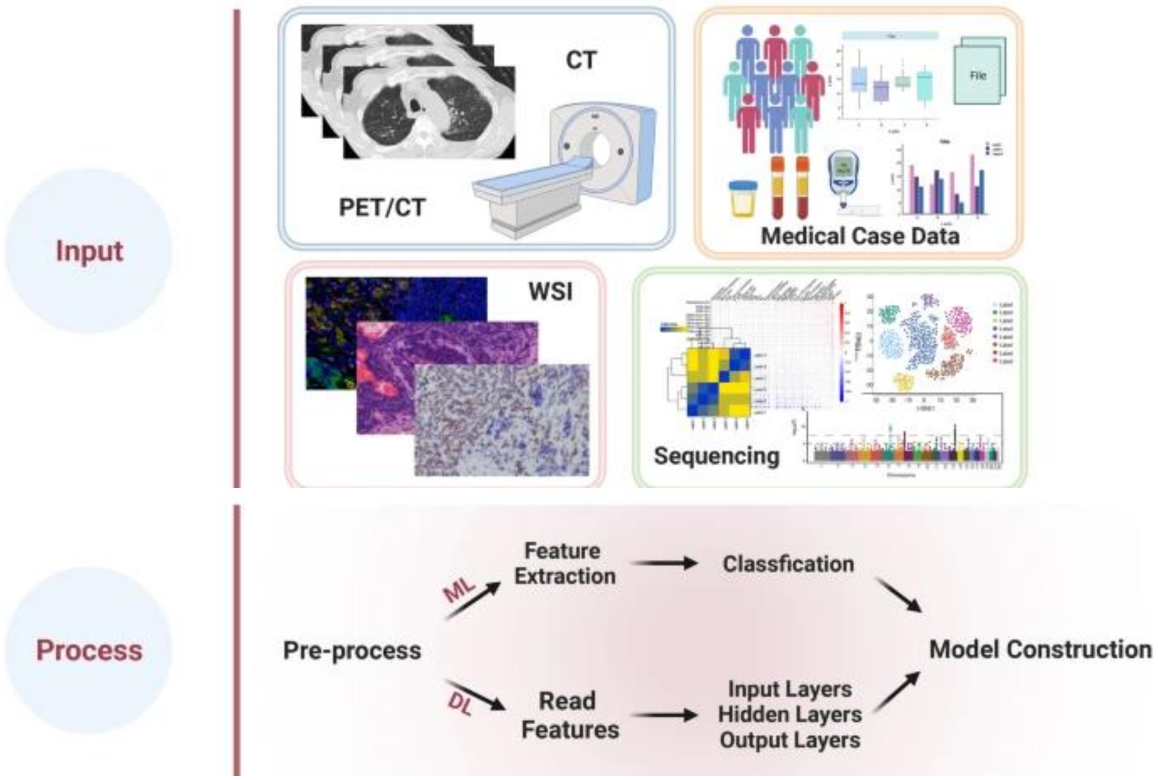


Predizione di mutazioni genetiche
Capacità di identificare driver: EGFR: 19Del, L858R, T790MALk
→ **Supporto alla scelta delle terapie mirate**

Supporto all'immunoterapia
Predizione dell'espressione: PD-L1Infiltrato CD8+ T
→ Utile per selezionare i pazienti candidabili a immunoterapia



How can AI predict PD-1/PD-L1 and TMB?

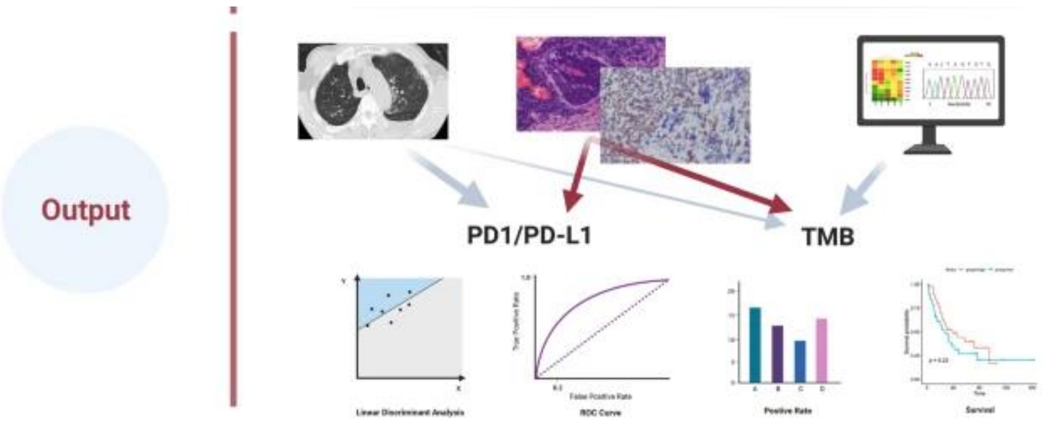


Review | Open access | Published: 24 May 2023

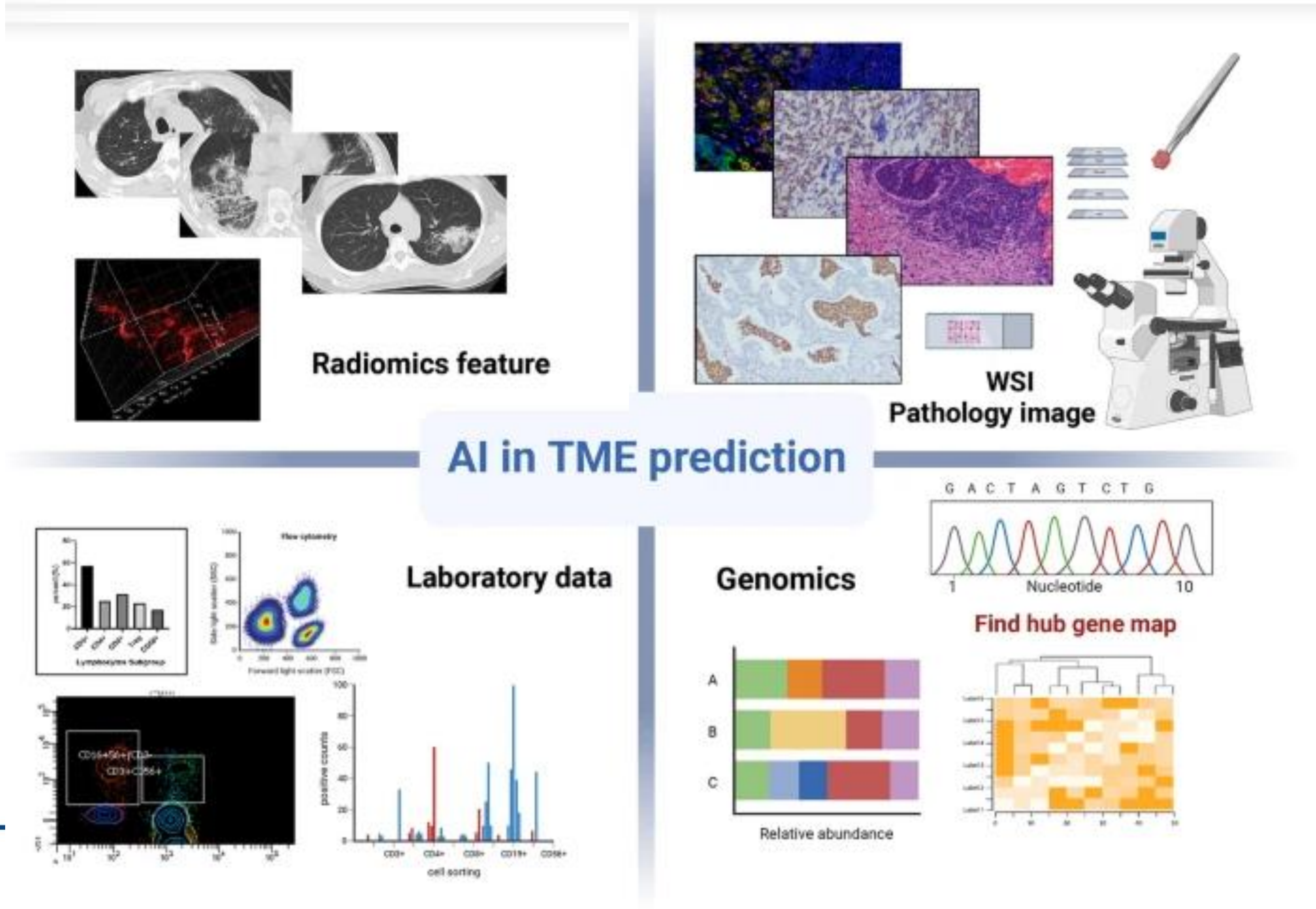
The artificial intelligence and machine learning in lung cancer immunotherapy

Qing Gao, Luyu Yang, Mingjun Lu, Renjing Jin, Huan Ye & Teng Ma

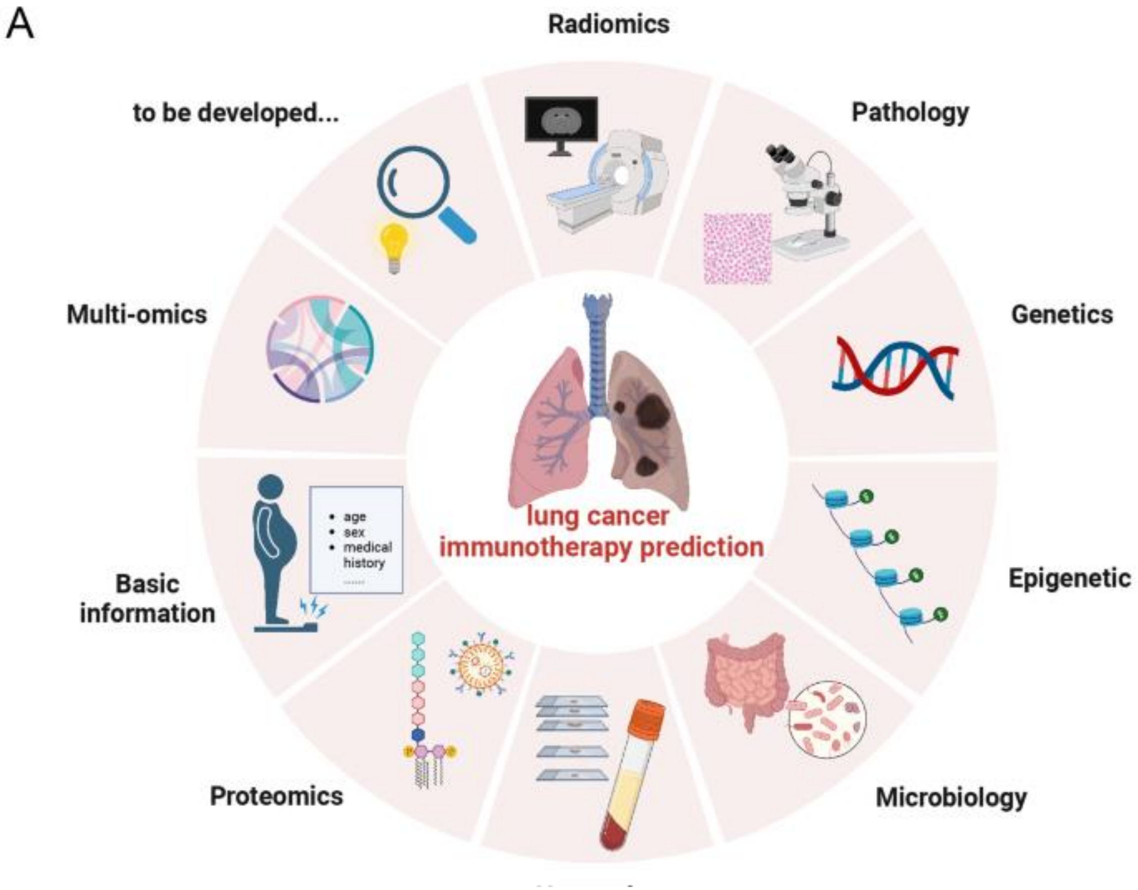
Journal of Hematology & Oncology **16**, Article number: 55 (2023) | Cite this article



Prospettive future: la radiomica non è sufficiente



Il futuro è la **multi-omica**



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The artificial intelligence and machine learning in lung cancer immunotherapy

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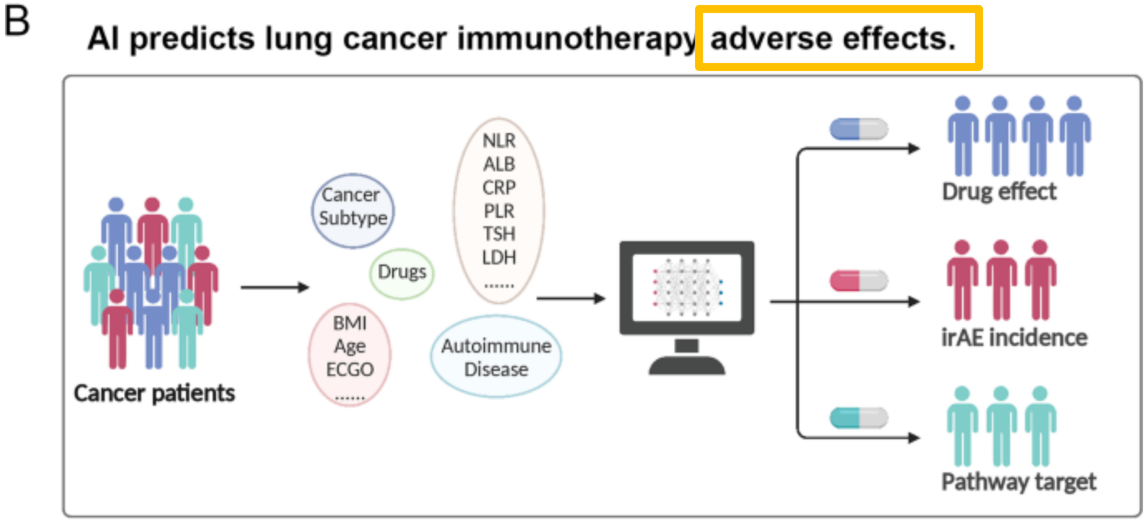
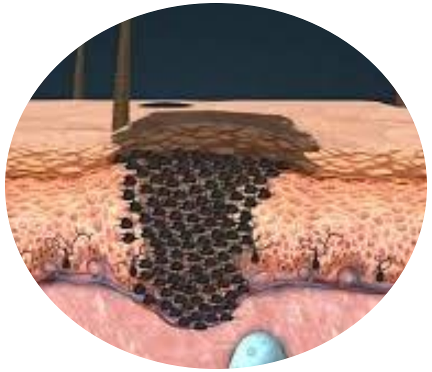


European Journal of Radiology Open
Volume 9, 2022, 100440

Feasibility of using CT radiomic signatures for predicting CD8-T cell infiltration and PD-L1 expression in renal cell carcinoma

Bino Varghese [a], Steven Cen [a], Haris Zahoor [b], Imran Siddiqui [c], Manju Aron [c], Akash Sali [d], Suhn Rhie [e], Xiaomeng Lei [a], Marielena Rivas [a], Derek Liu [a], Darryl Hwang [a], David Quinn [b], Mihir Desai [f], Ulka Vaishampayan [g], Inderbir Gill [f], Vinay Duddalwar [a]



Diagnostics

Review | 27 September 2023

Artificial Intelligence and Radiomics: Clinical Applications for Patients with Advanced Melanoma Treated with Immunotherapy

Jeremy McGale[1], Jakob Hama[2], Randy Yeh[3], Laetitia Vercellino[4], Roger Sun[5], Egesta Lopci[6], Samy Ammari[7,8] and Laurent Dercle[1,*]

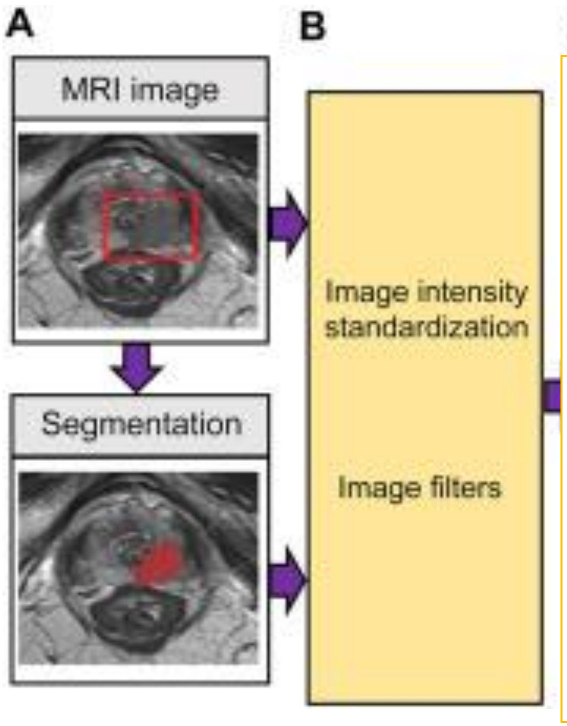
AI and prostate cancer

Review

Advancements in artificial intelligence for prostate cancer: Optimizing diagnosis, treatment, and prognostic assessment

Yuki Arita [a], Christian Roest [b], Thomas C. Kwee [b], Ramesh Paudyal [c], Alfonso Lema-Dopico [c], Stefan Fransen [b], Daisuke Hirahara [d], Eichi Takaya [d], Ryo Ueda [e], Lisa Ruby [a], Noam Nissan [a], Lawrence H. Schwartz [a], Amita Shukla-Dave [a c], Oguz Akin [a]

… il modus operandi è sempre lo stesso….



- **Migliore Rilevamento e Accuratezza Diagnostica → caratterizzazione lesioni**
- **Riduzione della Variabilità tra Osservatori**
- **Previsione dell'Aggressività del Cancro (Prognosi):** Modelli avanzati di IA, inclusa la radiomica con deep learning, possono estrarre caratteristiche dettagliate dalle immagini RM per prevedere l'aggressività (**Gleason Grade Group**) del cancro, spesso con maggiore accuratezza rispetto ai metodi tradizionali. Queste informazioni sono cruciali per decidere tra la sorveglianza attiva e opzioni di trattamento più aggressive.

From diagnosis to targeted therapy: a roadmap for AI in PCa care.

Review

Advancements in artificial intelligence for prostate cancer: Optimizing diagnosis, treatment, and prognostic assessment

Yuki Arita [a], Christian Roest [b], Thomas C. Kwee [b], Ramesh Paudyal [c], Alfonso Lema-Dopico [c], Stefan Fransen [b], Daisuke Hirahara [d], Eichi Takaya [d], Ryo Ueda [e], Lisa Ruby [a], Noam Nissan [a], Lawrence H. Schwartz [a], Amita Shukla-Dave [a c], Oguz Akin [a]

Article | Open access | Published: 21 August 2025

Artificial intelligence model for predicting early biochemical recurrence of prostate cancer after robotic-assisted radical prostatectomy

Miguel Angel Bergero, Pablo Martínez, Patricio Modina, Ricardo Hosman, Wenceslao Villamil, Romina Gudiño, Carlos David & Lucas Costa

Scientific Reports **15**, Article number: 30822 (2025) | Cite this article

ript:

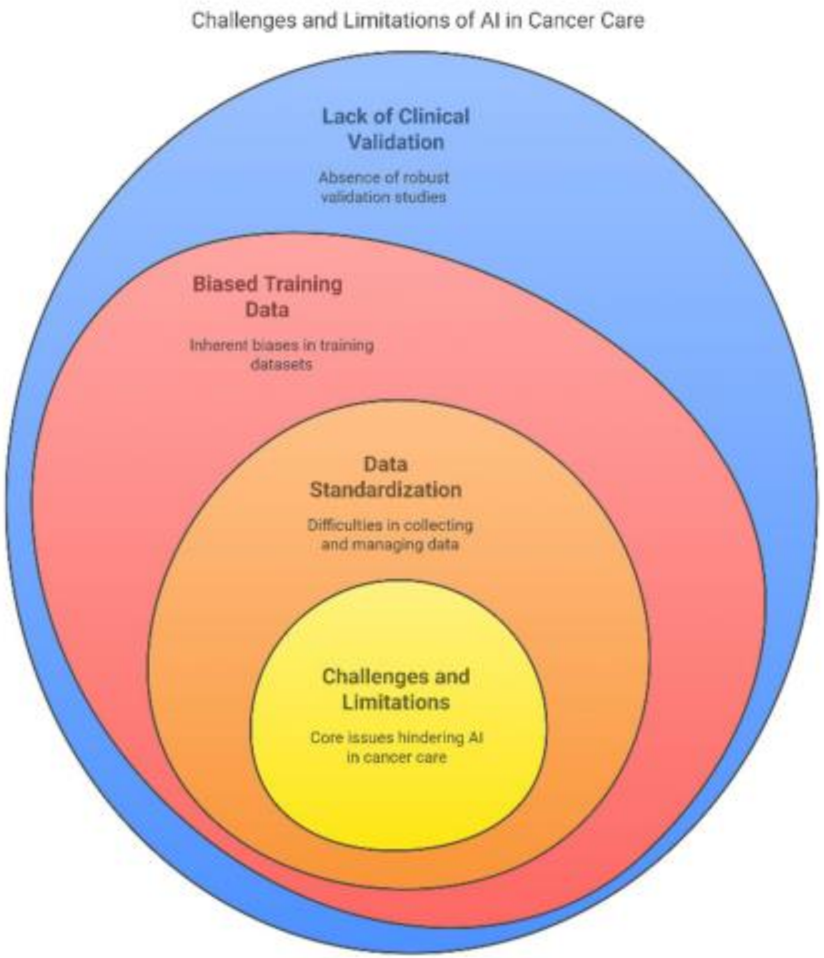
> NEJM Evid. 2023 Aug;2(8):EVIDoa2300023. doi: 10.1056/EVIDoa2300023. Epub 2023 Jun 29.

Artificial Intelligence Predictive Model for Hormone Therapy Use in Prostate Cancer

Prevedere quali pazienti hanno un'alta probabilità di sviluppare:

- estensione extracapsulare,
- recidiva e/o metastasi

→ trattamento più personalizzato.



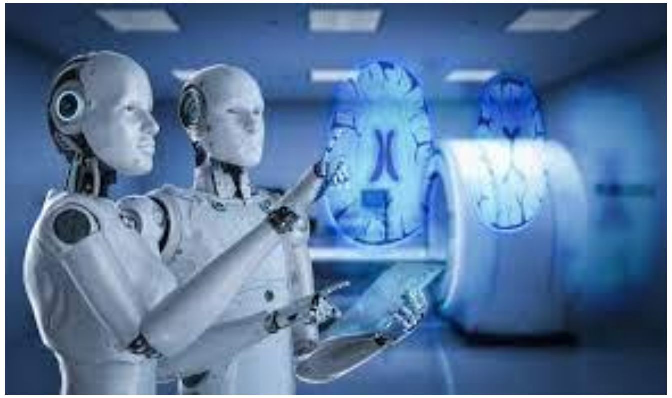
Limiti:

Sebbene l’utilizzo dell’AI per prevedere informazioni cliniche sia attualmente un **tema di ricerca molto attuale**, si trova ancora in una fase iniziale.
Si tratta di un tentativo innovativo e collaborativo tra esperti informatici e medici clinici, che non è ancora pienamente consolidato.
A causa di limitazioni pratiche (mancata condivisione dei dati delle coorti e la dimensione insufficiente dei campioni), i **modelli** riescono a ottenere buone prestazioni solo nei set di validazione interni, risultando quindi **difficili da generalizzare e applicare nella pratica clinica reale.**

L'intelligenza artificiale predittiva in oncologia utilizza il Machine learning per analizzare dati complessi dei pazienti **e prevedere** gli esiti dei trattamenti, identificare nuovi bersagli farmacologici e **stratificare i pazienti** per un'assistenza personalizzata.

Integrando dati «**multi-omici»**, di imaging e clinici, questi modelli di intelligenza artificiale possono migliorare la **selezione del trattamento**, **potenziare lo screening** e accelerare lo sviluppo di farmaci **prevedendo le risposte** dei pazienti **alle terapie**, migliorando l'efficienza degli studi clinici e potenzialmente superando i modelli di rischio tradizionali.
Tuttavia, **permangono delle sfid**e, tra cui bias dei dati, integrazione dei dati e necessità di convalida prima di una più ampia adozione clinica e sostenibilità economica nella dotazione dei sotware disponibili.

«L'AI sostituirà i radiologi?»
Domanda sbagliata



La risposta giusta:
i radiologi che la usano sostituiranno i radiologi che ne fanno a meno