

**Strengths, weaknesses and
opportunities of artificial intelligence (AI)
in radiation oncology**

Valerio Nardone

Department of Precision Medicine,
University of Campania «L. Vanvitelli», Naples

Disclosures

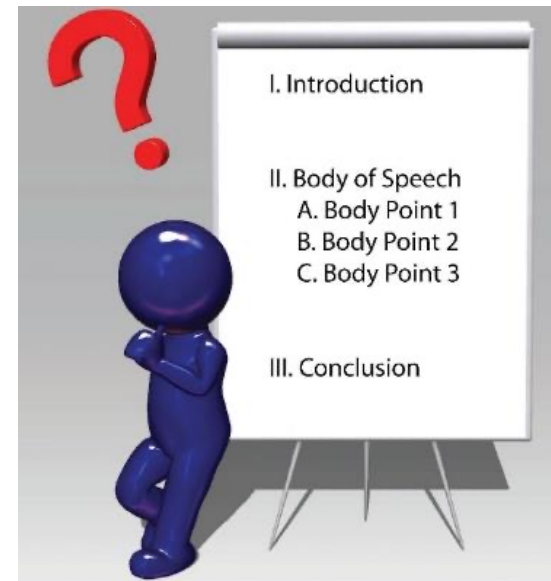
Per quanto concerne tale presentazione, dichiaro di non avere avuto alcuna relazione rilevante (diretta od indiretta) di tipo finanziario con alcuna compagnia farmaceutica negli ultimi 24 mesi che possa essere considerato un **conflitto di interesse**.



Outline

➤ **Definition;**

- **Application in RadOnc;**
- **Highlights from ESTRO;**
- **Highlights from ASTRO;**
- **Other application;**
- **Summary and conclusions;**



HIGHLIGHTS in RADIOTERAPIA

Update degli Studi Practice Changing 2022

In computer science, *artificial intelligence* (AI), is intelligence demonstrated by machines, in contrast to the *natural intelligence* displayed by humans and animals. The term AI is used to describe machines that mimic *cognitive* functions associated with human minds, such as *learning* and *problem solving*.



Other terms

- *Machine learning*: it is an application of AI that provides systems the ability to automatically learn and improve from experience without explicit programming;
- *Neural Networks*: are computing systems inspired by the biological neural networks and nodes called artificial neurons.
- *Data mining*: is the practice of examining large databases to generate new informations;



Automatic Recognition of Ripening Tomatoes by artificial intelligence

Artificial Intelligence in Factories



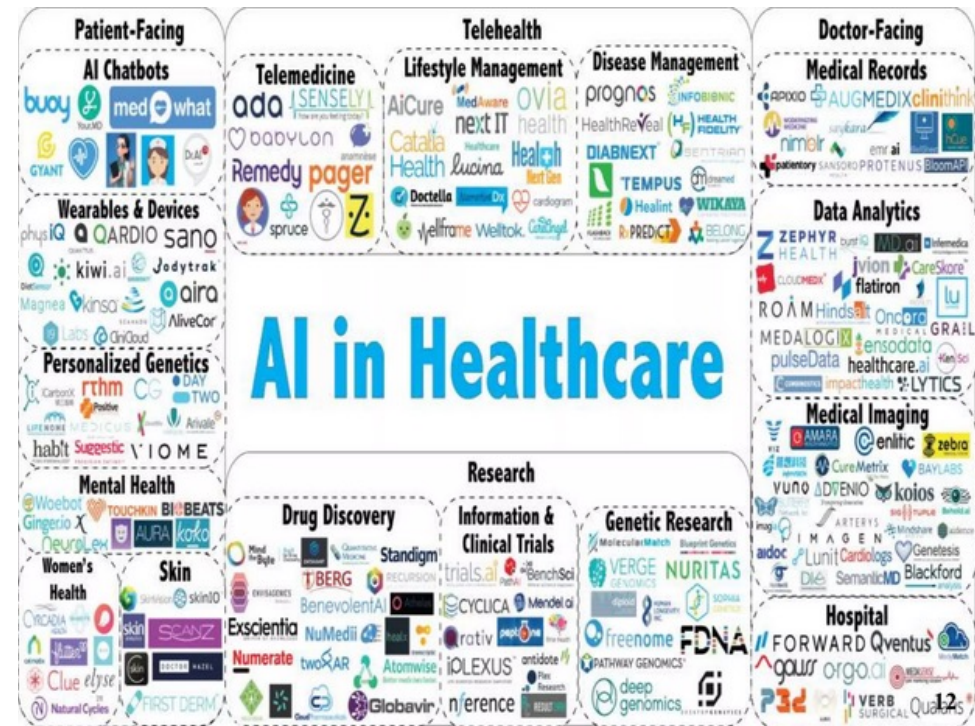
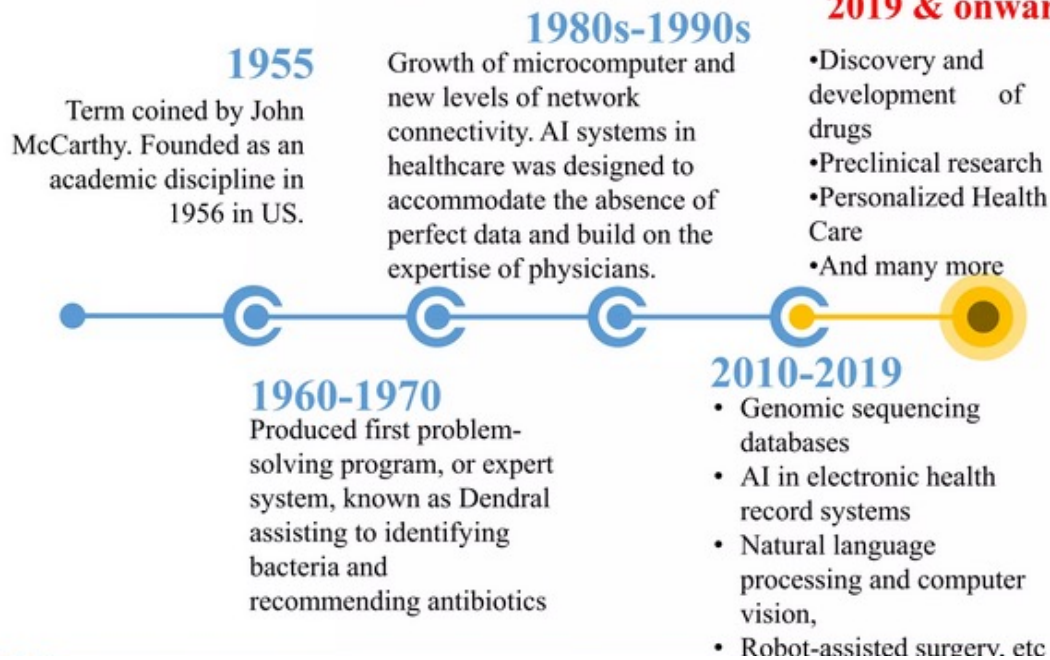
Japan ranked fourth in the world: In 2016, 303 robots were installed per 10,000 employees in the manufacturing industry.

HIGHLIGHTS in RADIOTERAPIA

Update degli Studi Practice Changing 2022

AI in Health

Timeline of AI in health



HIGHLIGHTS in RADIOTERAPIA

Update degli Studi Practice Changing 2022

Digital Life Con la sua intelligenza artificiale ChatGPT scrive articoli scientifici a prova di... revisione umana

Oltre a produrre conversazioni complesse, ChatGPT può scrivere abstract di articoli scientifici e pezzi divulgativi che sembrano scritti da umani.

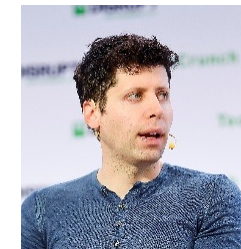
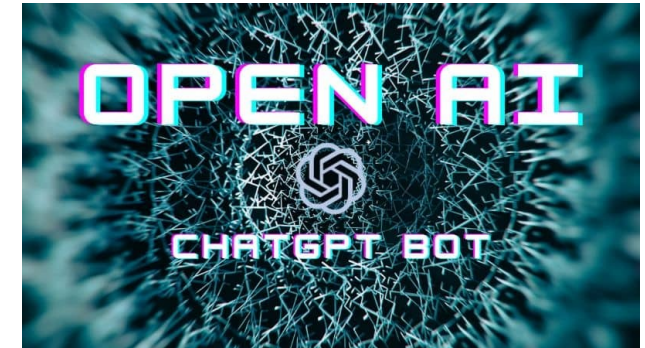


Special Reports > Exclusives

AI Passes U.S. Medical Licensing Exam

— Two papers show that large language models, including ChatGPT, can pass the USMLE

by [Michael DePeau-Wilson](#), Enterprise & Investigative Writer, MedPage Today January 19, 2023



Sam
Altman

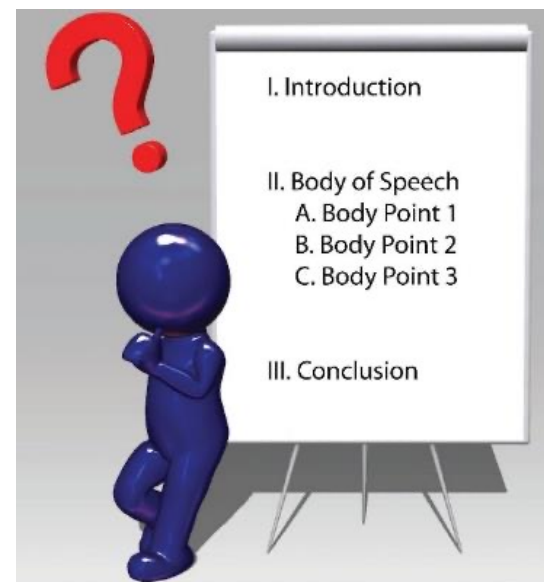
Generative storytelling has arrived.

<https://beta.tome.app/>

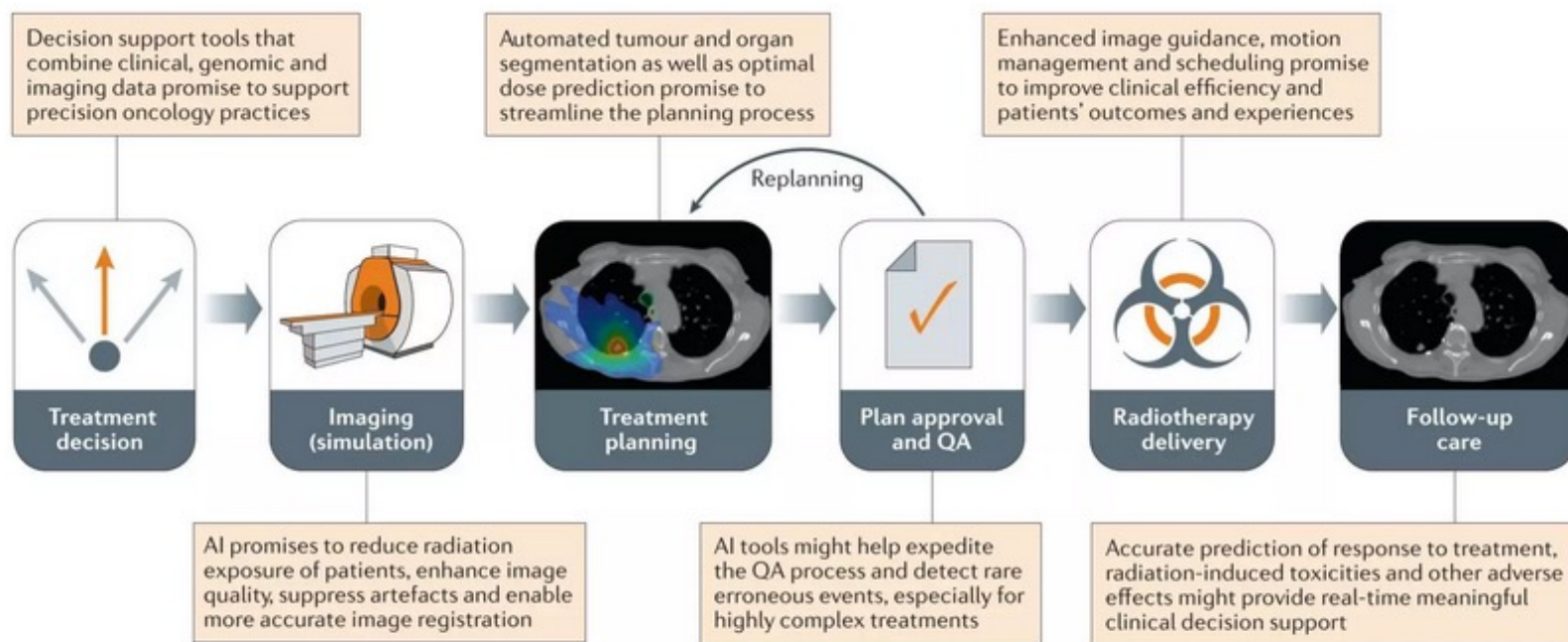
Unlock your best work with Tome's AI-powered storytelling format.

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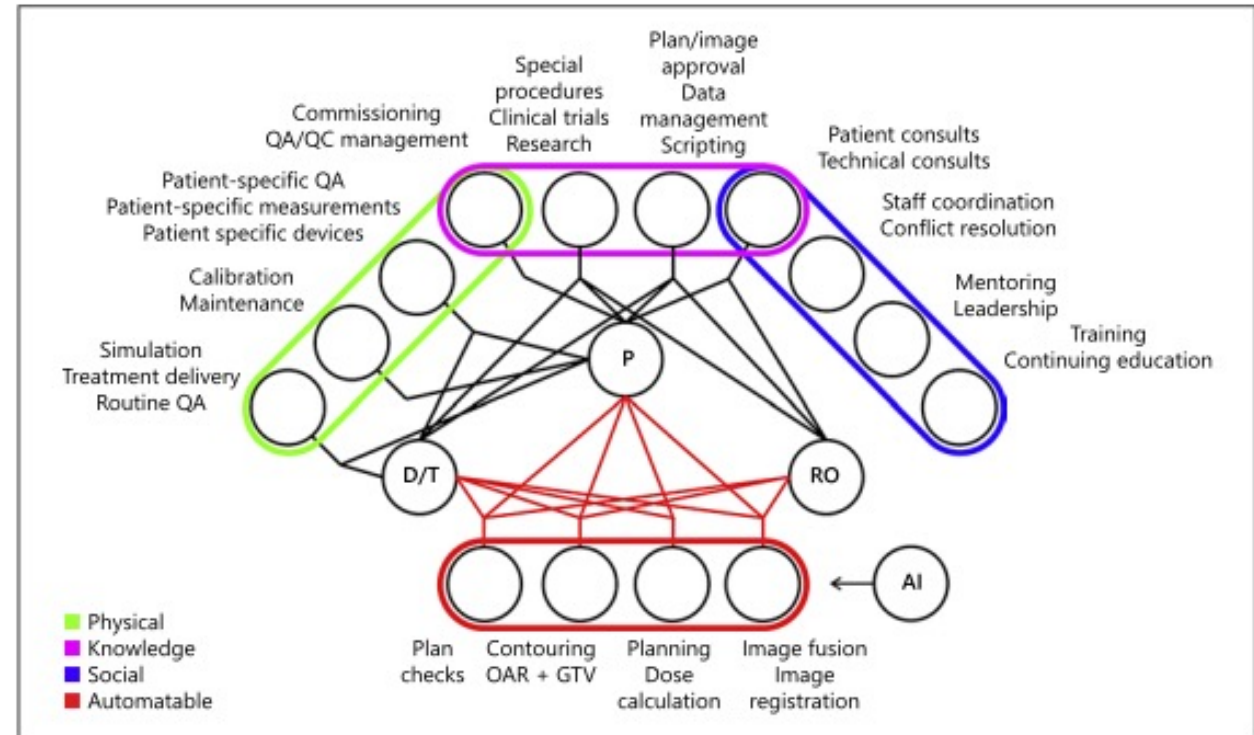
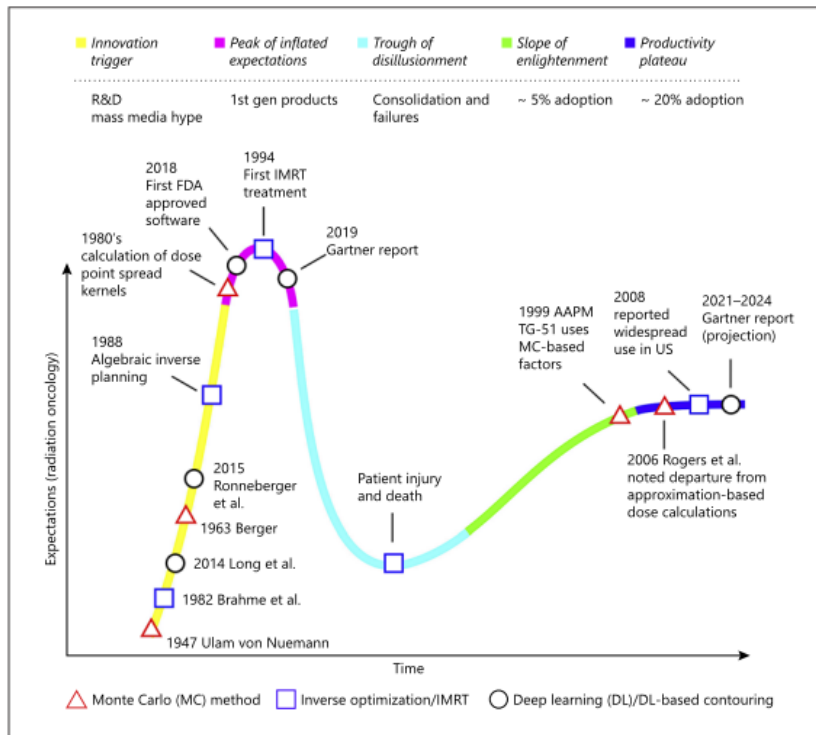


AI in Radiation Oncology



HIGHLIGHTS in RADIOTHERAPIA

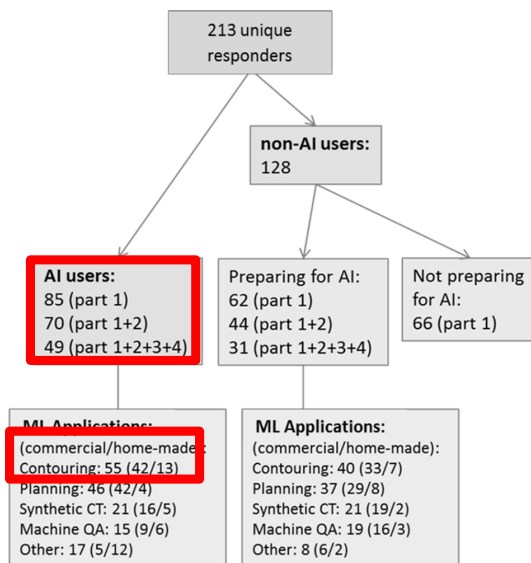
Update degli Studi Practice Changing 2022



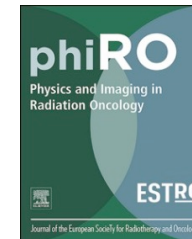
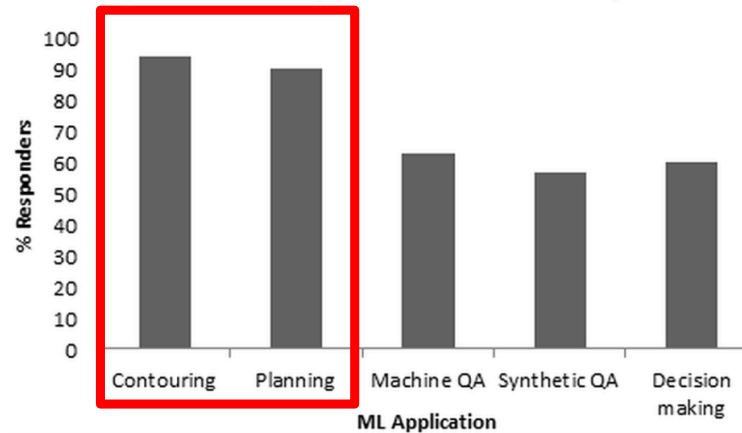
Hype cycle. This figure features a hype cycle curve for three major innovations in radiation oncology (triangle: Monte Carlo; square: Inverse optimization/IMRT; circle: deep learning-based contouring). The curve depicts expectations by the target audience (those in radiation oncology and medical physics) as a function of time. Yellow, magenta, cyan, green, and blue portions of the curve denote “innovation trigger,” “peak of inflated expectations,” “trough of disillusionment,” “slope of enlightenment,” and “productivity plateau” regions, respectively.

The Emergence of Artificial Intelligence within Radiation Oncology Treatment Planning, Tetherton et al. Oncology 2021

Use of AI in 2020



Expected ML Application within 5 years



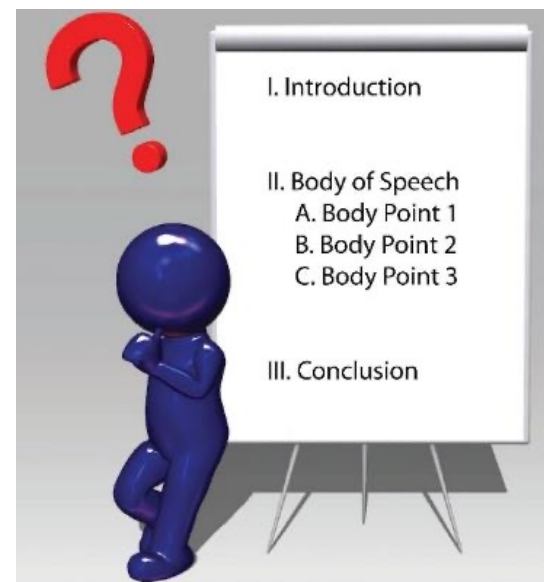
Supplemental Table 1. Number of Radiation Oncology Departments using or preparing to use machine learning applications in clinical practice per country

Country	Radiation Oncology Departments and Machine Learning Applications	
	Clinical	Preparing
France	8	5
Italy	7	3
Netherlands	8	3
Spain	7	2
Australia	5	4
Belgium	5	3
United Kingdom	4	3
Denmark	3	2
Switzerland	3	3
United States of Amerika	3	1
Germany	2	2
Norway	2	3

C.L. Brouwer et al. Physics and Imaging in Radiation Oncology 2020

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AI: friend or foe

AI is a friend

- Time reduction for the radiotherapist (contours, planning),
- Improve accuracy and precision in RT treatments,
- Predict toxicity,
- Cost reduction.

AI is a foe

- “ I may take your job “ ,
- Incorrect treatment decisions with incomplete or biased data,
- Manipulation of AI algorithms or steal patient data by hackers.

The image shows a presentation slide from the ESTRO 2022 Annual Congress. The slide features a yellow and orange geometric design. The main title is "Learning from Every Patient". Below the title, it states "6-10 May 2022" and "ONSITE IN COPENHAGEN & ONLINE". The ESTRO 2022 logo is prominently displayed. In the top right corner, there is a small video feed of a speaker, Michelle Leech (Ireland), with the text "ESTRO 2022" and "Michelle LEECH (IRELAND)" below it. The top of the slide includes the text "ESTRO 2022" and "Artificial intelligence: Friend or foe of the RTT?" with a chairperson name "Michelle Leech". The bottom right corner has icons for "Vote" and "Ask a question".

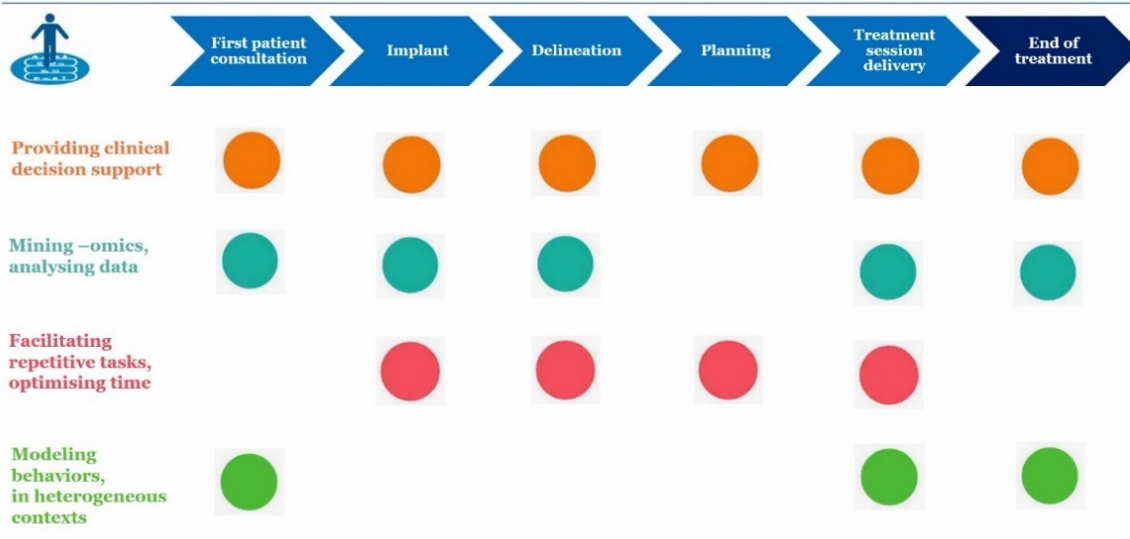
The image shows the ESTRO 2022 logo and event information. The text "ESTRO 2022" is in a large, bold font. To its right, it says "6-10 May 2022" and "Copenhagen, Denmark". The background features a yellow and orange geometric design.

HIGHLIGHTS in RADIOTERAPIA

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AI in Brachytherapy

THE RADIATION ONCOLOGIST POINT OF VIEW



ESTRO2022

08:30 The physician point of view

Auditorium 11



LUCA TAGLIAFERRI - MD, PhD

Artificial intelligence and brachytherapy:
Current reality and perspectives



Luca TAGLIAFERRI (ITALY)



ESTRO2022

08:30 The physicist point of view

Auditorium 11



Nicole Nesvacil
Dept. for Radiation Oncology
Medical University of Vienna

Artificial Intelligence and brachytherapy: Current
reality and perspectives
A physicist's point of view



Nicole NESVACIL (AUSTRIA)



ESTRO2022

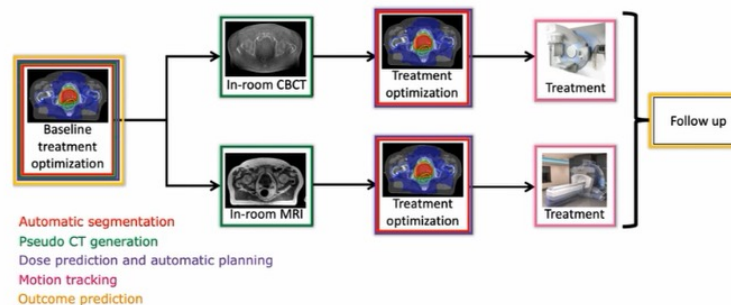
6-10 May 2022
Copenhagen, Denmark

AI in the RT workflow

Summary

Many roles for AI in the RT workflow

- AI algorithms are applicable to almost all aspects of the RT workflow
- Commercial solutions are now available
- Segmentation is one of the most visible applications
- Pseudo CT software is also making its way into the clinic
- Some aspects will naturally remain research topics



LMU KLINIKUM



ESTRO 2022

6-10 May 2022
Copenhagen, Denmark

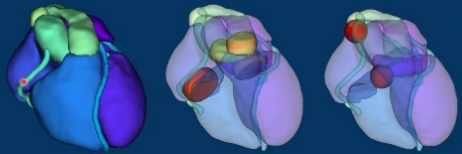
HIGHLIGHTS in RADIOTHERAPIA

Update degli Studi Practice Changing 2022

ESTRO2022 11:20 Development and implementation of a hybrid method for automatic cardiac ... Room D2

Development and implementation of a hybrid method for automatic cardiac substructure segmentation

Robert N Finnegan
Vicky Chin
Phillip Chlap
Ali Haidar
James Otton
Jason Dowling
David I Thwaites
Shalini K Vinod
Geoff P Delaney
Lois Holloway



ROBERT FINNEGAN (AUSTRALIA)

Our institutes:



ESTRO2022 11:41 SBRT for lung cancer and lung metastases: prospective national registration ... Room D2

SBRT for lung cancer and lung metastases: prospective national registration project in Belgium.

Yolande Lievens, MD, PhD
Radiation Oncology Department, Ghent University Hospital and Ghent University, Ghent, Belgium

On behalf of
Maarten Lambrecht, Leen Boesmans, Hilde Engels, Xavier Geets, Sharon Janssens, Luigi Moretti, Vincent Remouchamps, Sander Roosens, Nancy Van Damme.

Belgian College for Physicians of Radiation Oncology Centres
Belgian National Institute for Health and Disability Insurance (NIHDI – RIZIV/INAMI)
Belgian Cancer Registry



YOLANDE LIEVENS (BELGIUM)

ESTRO2022 16:30 Collecting Complete Radiotherapy Plan Data of 11,000+ Patients in a National... Room D2



DcmCollab

Collecting Complete Radiotherapy Plan Data of 11,000+ Patients in a National Database

Simon Long Krogh

Laboratory of Radiation Physics, Odense University Hospital, Denmark

Lorenzen, E, Laboratory of Radiation Physics, Odense University Hospital, Denmark
Hansen, CK, Laboratory of Radiation Physics, Odense University Hospital, Denmark
Samra, E, Department of Oncology, Radiotherapy, Zealand University Hospital, Naestved, Denmark
Vogelius, IB, Department of Oncology, Rigshospitalet, Denmark
Zukauskaite, R, Department of Oncology, Odense University Hospital, Denmark
Johansen, J, Department of Oncology, Odense University Hospital, Denmark
Ollori, A, Department of Oncology, Odense University Hospital, Denmark
Ruhmann, CH, Department of Oncology, Odense University Hospital, Denmark
Hoffmann, L, Department of Oncology, Aarhus University Hospital, Denmark
Nissen, HD, Department of Oncology, Vejle Hospital, University Hospital of Southern Denmark
Nielsen, MS, Department of Oncology, Aalborg University Hospital, Denmark
Andersen, K, Department of Oncology, Copenhagen University Hospital - Herlev and Gentofte, Denmark
Grau, C, Department of Oncology, Aarhus University Hospital, Aarhus, Denmark
Brink, C, Laboratory of Radiation Physics, Odense University Hospital, Denmark



ESTRO2022

SIMON KROGH (DENMARK)

ESTRO2022 11:00 TRIPOD level-4 validation for a larynx cancer survival model using distributed... Room D2



DAHANCA

Open-source distributed learning validation for a larynx cancer survival model following radiotherapy

Christian Rønn Hansen^{1,2,3,4}, Gareth Price⁵, Matthew Field⁶, Nis Sarup¹, Ruta Zukauskaite^{2,7}, Jørgen Johansen⁸, Jesper Grau Eriksen^{3,9}, Farhannah Aly^{6,10,11}, Andrew McPartlin⁵, Lois Holloway^{6,10,11}, David Thwaites⁴, Carsten Brink^{1,2}

1. Laboratory of Radiation Physics, Odense University Hospital, Odense, DK
2. Department of Clinical Research, Odense, DK
3. Danish Centre for Particle Therapy, Aarhus University Hospital, DK
4. Institute of Medical Physics, School of Physics, University of Sydney, AU
5. Radiotherapy department, The Christie NHS Foundation Trust, Manchester, UK
6. Ingham Institute for Applied Medical Research, Sydney, AU
7. Department of Oncology, Odense University Hospital, Odense, DK
8. Department of Experimental Clinical Oncology, Aarhus University Hospital, DK
9. Department of Oncology, Aarhus University Hospital, DK
10. SouthWest Sydney Clinical Campus, University of New South Wales, AU
11. Liverpool and Macarthur Cancer Therapy Centres, Sydney, AU



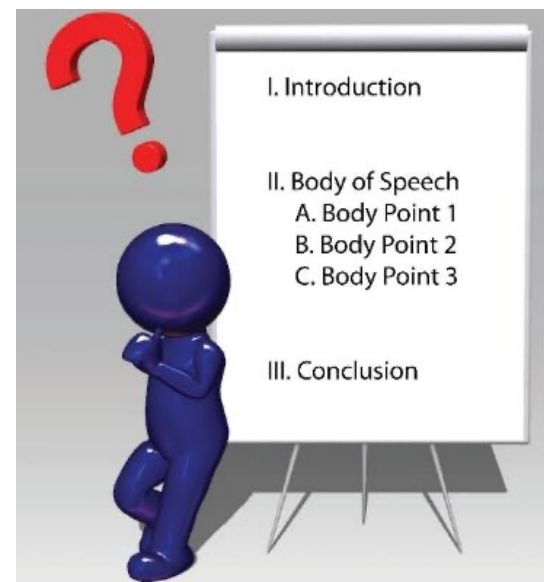
CHRISTIAN RÖNN HANSEN (DENMARK)

Other Hints



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HIGHLIGHTS in RADIOTERAPIA

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Emotional intelligence is defined as **the ability to understand and manage your own emotions, as well as recognize and influence the emotions of those around you.** The term was first coined in 1990 by researchers John Mayer and Peter Salovey, but was later popularized by psychologist Daniel Goleman.

Impact of AI on Quality of Care, Clinical Practice and Training

- Variation in quality exists, but regionalization is NOT the solution;
 - AI can reduce unrewarding tasks that consume time/cognitive burden;
 - AI can also inform or facilitate strategies to enhance quality (simulation training for complex cases, patient selection for escalation of clinical care);
- **There will be pluses and minuses, but change is certain;**
- **Success will come through networking within us and across disciplines;**



Erin Gillespie

Deep learning in digital histopathology for prostate cancer

- AI derived prognostic biomarkers provide personalized risk estimates, that when grouped allows more streamlined communication;
- ArteraAI MMAI prognostic tool identifies 6-fold more low-risk patients than NCCN (safe omitting of ADT with RT, with a NNT>25);
- **Prognostic biomarkers help with shared-decision making to avoid futile treatment intensification;**
- **Use of AI tools leveraging digital pathology improves prognostication, enabling us to determine the optimal treatment plan for the single patient (precision medicine);**

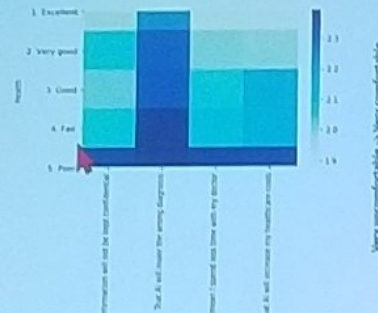


Jonathan Tward

Current Progress of Machine Learning in Radiation Oncology

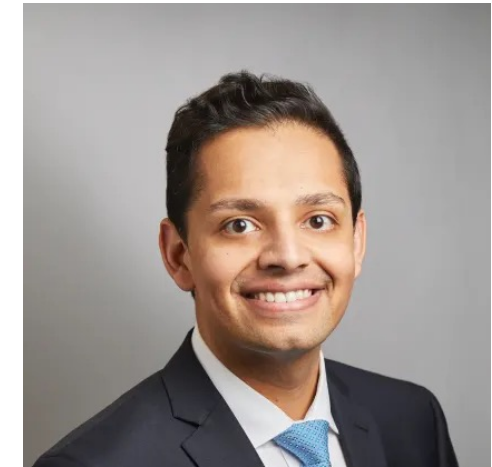
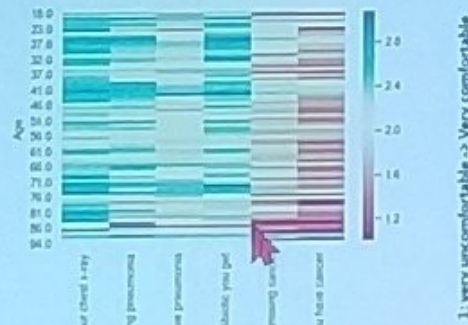
Please tell me how concerned you are about the use of AI in medicine for each of the following:

1. That my health information will be kept confidential
2. That AI will make the wrong diagnosis
3. That AI will mean I spend less time with my doctor
4. That AI will increase my healthcare costs



For each of the following, please tell me how comfortable you would feel with AI doing some of the things your doctor usually does:

1. Reading your chest x-ray
2. Diagnosing pneumonia
3. Telling you that you have pneumonia
4. Recommending your antibiotic
5. Diagnosing cancer
6. Telling you that you have cancer



Sanjay Aneja

Exploring ethical challenges in RadOnc AI

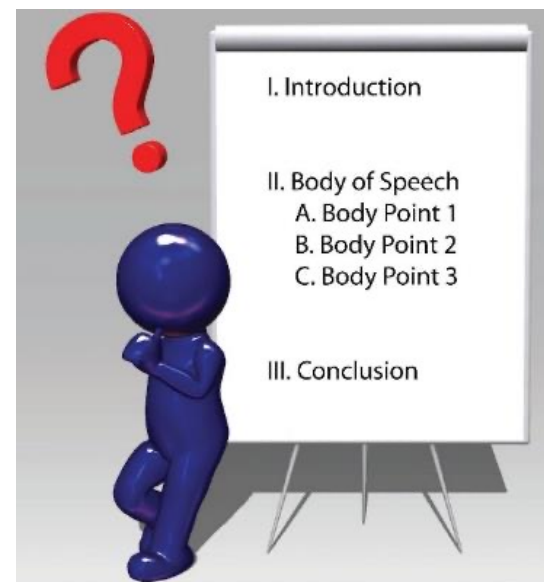
- While waivers can be ethical and pragmatic solutions, patients have no idea that AI is being used in research or care involving them;
- **If for minimal risk for quality systems we can rely on good ML practice, for higher risk we necessitate prospective informed consent!**
- Umbrella consent needed to inform patients;
- **Additional disclosure duties: patient access to information about specific AI algorithms used in their care;**



Subha Perni

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Cost-effectiveness analysis in oncology with AI

JAMA Oncology | **Brief Report**

Long-term Effect of Machine Learning-Triggered Behavioral Nudges on Serious Illness Conversations and End-of-Life Outcomes Among Patients With Cancer: A Randomized Clinical Trial

JAMA 2023

Christopher R. Manz, MD; Yichen Zhang, PhD; Kan Chen, MA; Qi Long, PhD; Dylan S. Small, PhD; Chalanda N. Evans, BS; Corey Chivers, PhD; Susan H. Regli, PhD; C. William Hanson, MD; Justin E. Bekelman, MD; Jennifer Braun, MHA, RN, BSN; Charles A. L. Rareshide, MS; Nina O'Connor, MD; Pallavi Kumar, MD, MPH; Lynn M. Schuchter, MD; Lawrence N. Shulman, MD; Mitesh S. Patel, MD, MBA; Ravi B. Parikh, MD, MPP



Article
Economics of Artificial Intelligence in Healthcare: Diagnosis vs. Treatment

Narendra N. Khanna ¹, Mahesh A. Maindarkar ^{2,3}, Vijay Viswanathan ⁴, Jose Fernandes E Fernandes ⁵,

Healthcare 2023

CONCLUSIONS AND RELEVANCE In this randomized clinical trial, a machine learning-based behavioral intervention and behavioral nudges to clinicians led to an increase in SICs and reduction in end-of-life systemic therapy but no changes in other end-of-life outcomes among outpatients with cancer. These results suggest that machine learning and behavioral nudges can lead to long-lasting improvements in cancer care delivery.

Genomic analysis in oncology with AI

JAAD 2021

Validation of a 40-gene expression profile test to predict metastatic risk in localized high-risk cutaneous squamous

JAAD 2021 cell carcinoma



Ashley Wysong, MD, MS,^a Jason G. Newman, MD,^b Kyle R. Covington, PhD,^c Sarah J. Kurley, PhD,^c Sherrif F. Ibrahim, MD, PhD,^d Aaron S. Farberg, MD,^{e,f} Anna Bar, MD,^g Nathan J. Cleaver, DO,^h Ally-Khan Somani, MD, PhD,ⁱ David Panther, MD,^j David G. Brodland, MD,^j John Zitelli, MD,^j Jennifer Toyohara, MD,^k Ian A. Maher, MD,^l Yang Xia, MD,^m Kristin Bibbee, MD,ⁿ Robert Griego, MD,^o Darrell S. Rigel, MD,^p Kristen Meldi Plasseraud, PhD,^c Sarah Estrada, MD,^{q,r} Lauren Meldi Sholl, MS,^q Clare Johnson, RN,^q Robert W. Cook, PhD,^c Chrysalyné D. Schmults, MD, MSCE,^s and Sarah T. Arron, MD, PhD^t

Seminars in Cancer Biology 88 (2023) 187–200

Contents lists available at ScienceDirect

Seminars in Cancer Biology

journal homepage: www.elsevier.com/locate/semcancer



Artificial intelligence-based multi-omics analysis fuels cancer precision medicine

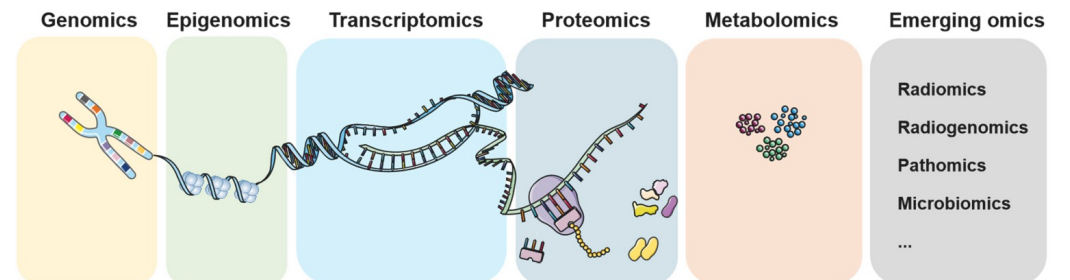
Xiujing He¹, Xiaowei Liu¹, Fengli Zuo, Hubing Shi, Jing Jing^{*}

2023

Development and validation of a nomogram incorporating gene expression profiling and clinical factors for accurate prediction of metastasis in patients with cutaneous melanoma following Mohs micrographic surgery



Ryan B. Thorpe, MD,^a Kyle R. Covington, PhD,^b Hillary G. Caruso, PhD,^b Ann P. Quick, PhD,^b



The information provided by omics technologies

- point mutations
- small insertions/deletions
- genomic rearrangements
- viral-genome insertions
- structural variants
- copy-number variants
- DNA modifications
- histone modifications and variants
- nucleosome occupancy
- chromatin interactions
- chromatin domains
- gene expression
- noncoding RNAs
- alternative splicing
- alternative polyadenylation
- gene fusions
- allele-specific expression
- RNA editing
- endogenous retrotransposon transcription
- identification and quantitation of proteins
- protein modifications
- identification and quantitation of metabolites
- drug metabolism and toxicity
- cancer metabolic reprogramming
- immunometabolism
- cell composition, cell morphology, and spatial context
- quantitative features from digital images
- microenvironment information

Representative techniques

- WGS
- WES
- WGBS
- CHIP-seq
- MeRIP-Seq
- ATAC-seq
- 3C and derivatives
- Microarray
- RNA-seq
- MS-based proteomics technology
- SMPS
- NMR spectroscopy
- MS-based metabolomics technology
- PET/CT, MRI, Dermoscopic images, Mammograms, H&E
- WMS, 16S rRNA gene sequencing

Genomic analysis in oncology with AI: the risk for RADONC

original reports

Development and Validation of a Genomic Profile for the Omission of Local Adjuvant Radiation in Breast Cancer JCO 2023

Martin Sjöström, MD, PhD^{1,2}; Anthony Fyles, MD³; Fei-Fei Liu, MD³; David McCreedy, MD³; Wei Shi, MSc³; Katrina Rey-McIntyre, MBA, BSc³; S. Laura Chang, PhD⁴; Felix Y. Feng, MD²; Corey W. Speers, MD, PhD⁵; Lori J. Pierce, MD⁵; Erik Holmberg, PhD⁶; Mårten Fernö, PhD¹; Per Malmström, MD, PhD^{1,7}; and Per Karlsson, MD, PhD⁶

BUT CONSIDER THIS

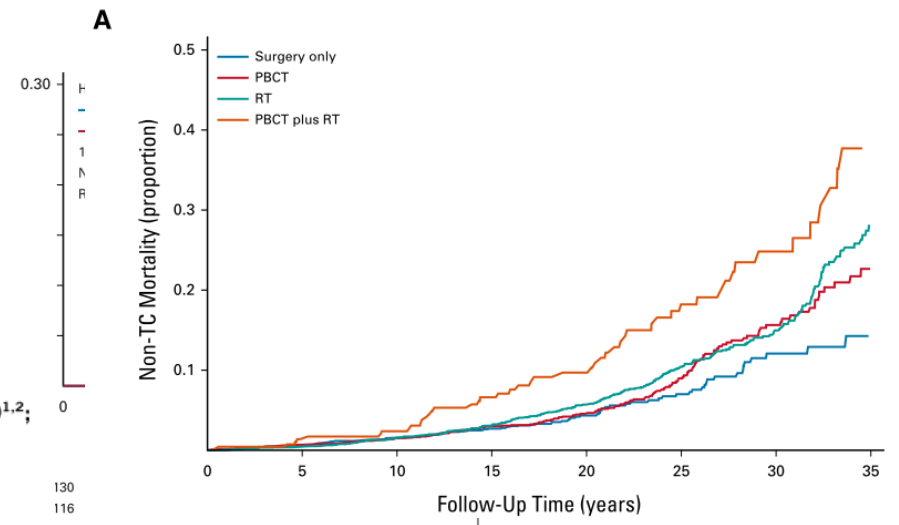
Testicular Cancer in the Cisplatin Era: Causes of Death and Mortality Rates in a Population-Based Cohort

Ragnhild Hellesnes, MD^{1,2}; Tor Åge Myklebust, PhD^{3,4}; Sophie D. Fosså, MD, PhD^{4,5,6}; Roy M. Bremnes, MD, PhD^{1,2}; Åsa Karlsdottir, MD, PhD⁷; Øivind Kvammen, MD, PhD⁸; Torgrim Tandstad, MD, PhD^{9,10}; Tom Wilsgaard, PhD¹¹; Helene F. S. Negaard, MD, PhD⁵; and Hege S. Haugnes, MD, PhD^{1,2}

21-Gene recurrence score predictive for prognostic benefit of radiotherapy in patients age ≥ 70 with T1N0 ER/PR + HER2- breast cancer treated with breast conserving surgery and endocrine therapy

Neil Chevli • Waqar Haque • Kevin T. Tran • ... Sandra S. Hatch • E. Brian Butler • Bin S. Teh & Show all authors

Published: June 27, 2022 • DOI: <https://doi.org/10.1016/j.radonc.2022.06.013> • Check for updates



HIGHLIGHTS in RADIOTERAPIA

Update degli Studi Practice Changing 2022

Genomic analysis in oncology with AI: the opportunity for RADONC

original reports

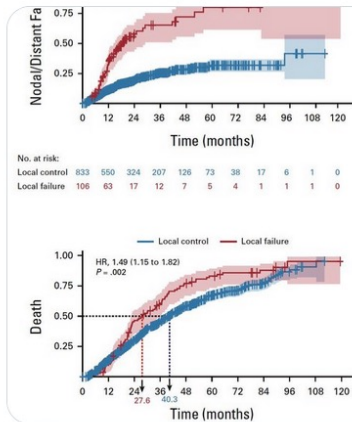


Drew Moghanaki @DrewMoghanaki · 16h

In risposta a @theabzlab

Congratulations on pushing us into the future.

I noticed a very high event rate in your cohort, suggesting these data will need to be validated in a healthier cohort to be applicable to operable pts.



1 1 153 1

pts in the other lung or pleura
 ory were excluded from univar
 ultivariate analyses because o
 w sample size and variability in
 ogic subtypes. Local failure wa
 d as radiographic progression
 1 cm of the planning target
 e to maintain a consistent
 ion of local/marginal failure in
 l trials of SBRT.^{1,13,14} Prescripti



Drew Moghanaki @DrewMoghanaki · 16h

In risposta a @DrewMoghanaki e @theabzlab

This is a MUST READ paper for anyone coding local failures after SBRT. It shows how easy, but not how often, it is for coders to be fooled and overcall LF. [doi.org/10.1016/j.ijro...](https://doi.org/10.1016/j.ijro)

idence of High-Risk Radiologic Features in
 ients Without Local Recurrence After
 reotactic Ablative Radiation Therapy for
 y-Stage Non-Small Cell Lung Cancer

Ronden, BSc,* J.R. van Sörnsen de Koste, PhD,* C. Johnson, BSc,
 Slatman, MD, PhD,* F.O.B. Spoelstra, MD, PhD,*
 Haasbeek, MD, PhD,* G. Blom, MD,* E.M. Bongers, MD,*
 armer, MSc,* A. Ward, PhD, D. Palma, MD, PhD, FRCPC,
 i. Senan, MRCP, FRCR, PhD*

Department of Radiation Oncology, VU Medical Center, Amsterdam, The Netherlands; *London School of Cancer Program, London Health Sciences Centre, London, Ontario, Canada; and
 †Institutes of Oncology and Medical Biophysics, University of Western Ontario, London, Ontario,

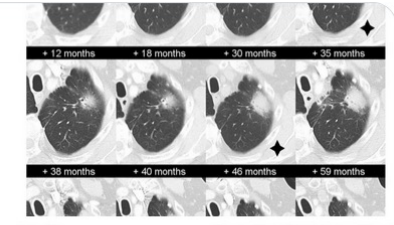
3 Jun 1, 2017, and in revised form Sep 11, 2017. Accepted for publication Sep 14, 2017.

Background: Stereotactic ablative radiotherapy (SBART) for early-stage non-small cell lung cancer (NSCLC) is associated with a high rate of local failure. It is difficult to distinguish between local failure and local recurrence. The purpose of this study was to investigate the incidence of high-risk radiologic features (HRFs) in patients known to have local failure after SBART.

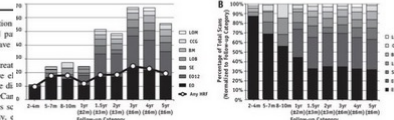
Purpose: To investigate, in the setting of stereotactic ablative radiation (SBART) for early-stage non-small cell lung cancer, the incidence and pathologic change in high-risk radiologic features (HRFs) in patients known to have local failure.

Methods and Materials: Computed tomography (CT) scans of patients treated with SBART for early-stage NSCLC between 2008 and 2013 were reviewed. All follow-up scans were available for 2 years and no local recurrences were identified. All scans were reviewed at a workstation using an add-on tool for ClearCare (Caption Medical). Five clinicians who were blinded to clinical outcomes searched for HRFs: enlarging opacity (EO), sequential enlarging opacity (EO2), bulging margin, loss of linear margin, cranial growth, and loss of air bronchogram. After each review, clinicians recommended follow-up procedures based on published recommendations.

Results: A total of 88 patients (217 CT scans) were evaluated. The HRFs frequently recorded by ≥3 observers on at least 1 follow-up scan were EO



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Cumulative mean incidence rates of each high-risk radiologic feature (HRF) per follow-up category, based on 100 patients and 217 CT scans for (A) percentage of total scans with overall incidence rates of any HRF, and (B) percentage of total scans normalized to follow-up category cumulative totals. Abbreviations: BM = bulging margin; EO = cranial-caudal growth; EO2 = enlarging opacity; EO12 = enlarging opacity after 12 months; LOB = loss of linear margin; LOM = loss of linear margin; SE = sequential enlarging opacity.

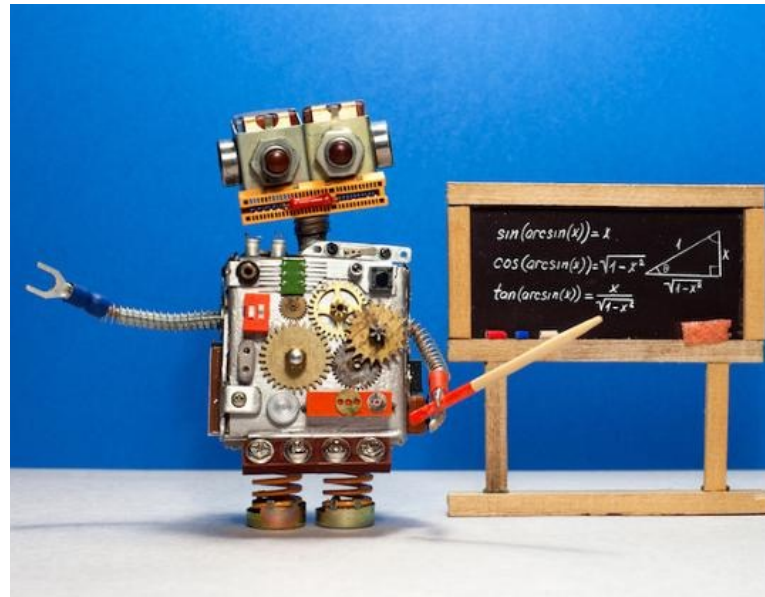
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in

HIGHLIGHTS in RADIOTERAPIA

Update degli Studi Practice Changing 2022

Things to remember: AI performance depends on the TRAINING



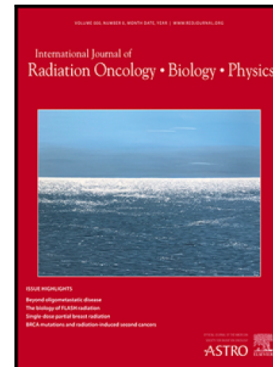
Genomic analysis in oncology with AI: the opportunity for RADONC

Journal Pre-proof

Red Journal 2022

Genomic classifiers in personalized prostate cancer radiotherapy approaches – a systematic review and future perspectives based on international consensus

Simon K.B. Spohn MD , Cédric Draulans MD ,
Amar U. Kishan MD , Daniel Spratt MD , Ashley Ross MD, PhD ,
Tobias Maurer Prof. MD , Derya Tilki Prof., MD ,
Alejandro Berlin MD , Pierre Blanchard MD, PhD ,
Sean Collins MD , Peter Bronsert MD , Ronald Chen MD, PhD ,
Alan Dal Pra MD , Gert de Meerleer MD, Prof. ,
Thomas Fede MD, Prof. , Karin Haustermans MD, Prof.



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Personalizing Radiotherapy Prescription Dose Using Genomic Markers of Radiosensitivity and Normal Tissue Toxicity in Non-Small Cell Lung Cancer

Jacob G. Scott^{1,2,†,*}, Geoff Sedor^{2,†}, Jessica A. Scarborough^{1,2}, Michael W. Kattan³, Jeffrey Peacock⁴, G. Daniel Grass⁴, Eric A. Mellon⁵, Ram Thapa⁶, Michael Schell⁶, Anthony Waller⁷, Sean Poppen⁸, George Andl⁷, Jamie Teer⁶, Steven A. Eschrich⁶, Thomas J. Dilling⁴, William S. Dalton⁹, Louis B. Harrison⁴, Tim Fox⁷, Javier F. Torres-Roca^{3,*}

Pan-cancer prediction of radiotherapy benefit using genomic-adjusted radiation dose (GARD): a cohort-based pooled analysis

Jacob G Scott, DPhil [†] • Geoffrey Sedor, MD [†] • Patrick Ellsworth, BA • Jessica A Scarborough, MS •

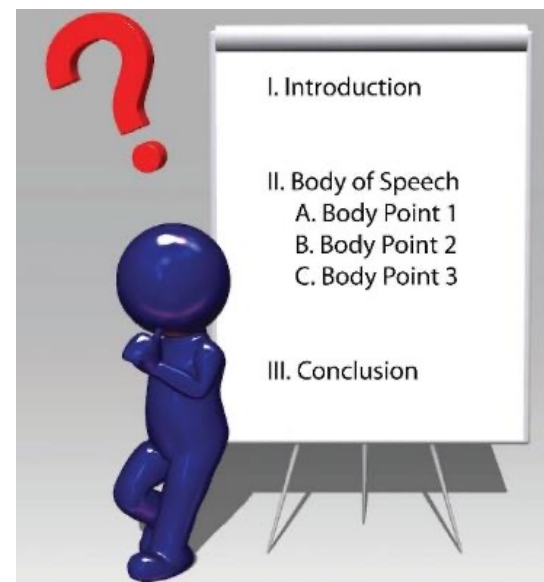
Kamran A Ahmed, MD • Daniel E Oliver, MD • et al. [Show all authors](#) • [Show footnotes](#)

Published: August 04, 2021 • DOI: [https://doi.org/10.1016/S1470-2045\(21\)00347-8](https://doi.org/10.1016/S1470-2045(21)00347-8) •



Outline

- **Definition;**
- **Application in RadOnc;**
- **Highlights from ESTRO;**
- **Highlights from ASTRO;**
- **Other application;**
- **Summary and conclusions;**



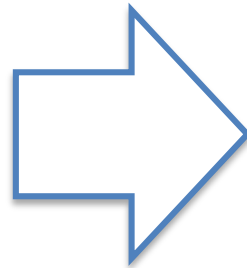
SUMMARY

- In the next years we will see many different application of AI in RadOnc workflow;
- Current applications focus on contouring, planning, adaptive;
- Future development in other areas (genomic profiling, radiomics) could have an high impact on RadOnc;
- Ethical challenges need to be solved;
- A big effort of RadOnc community is needed to train and validate AI approaches (networking is the key);



CONCLUSIONS

Don't be afraid
of the future



Where were we
until 20 years ago?



3DRT



IMRT



VMAT



MRI-LINAC



Advanced
SRT



?

There is no SOUL in
the MACHINE.
Only in front of it.



Without you, it's just DATA.

HIGHLIGHTS in RADIOTERAPIA

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della Campania
Luigi Vanvitelli

