The young side of LYMPHOMA

gli under 40 a confronto

Verona, Centro Congressi Camera di Commercio
26-27 settembre 2025

La Protonterapia nel giovane adulto affetto da cHL

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Disclosures of Angelo Vitullo

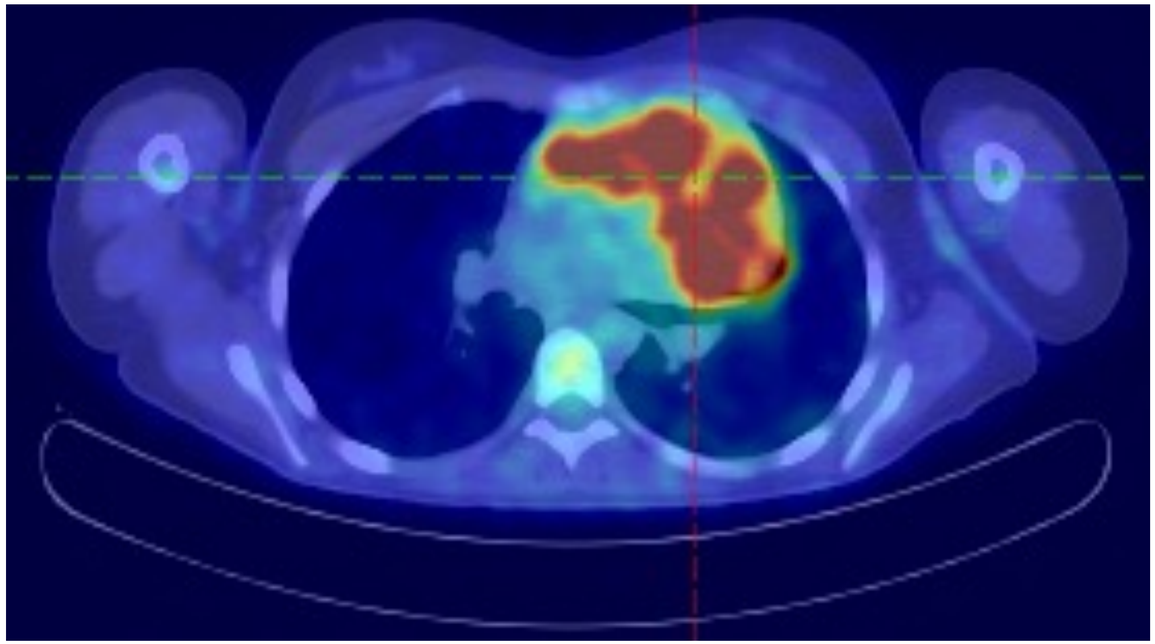
Nothing to disclose

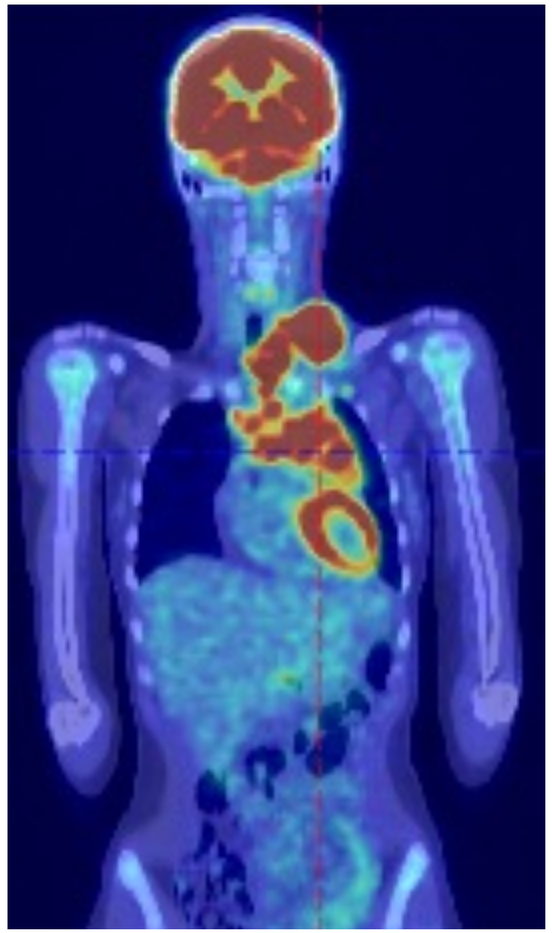
2019: **Donna, 18 anni**

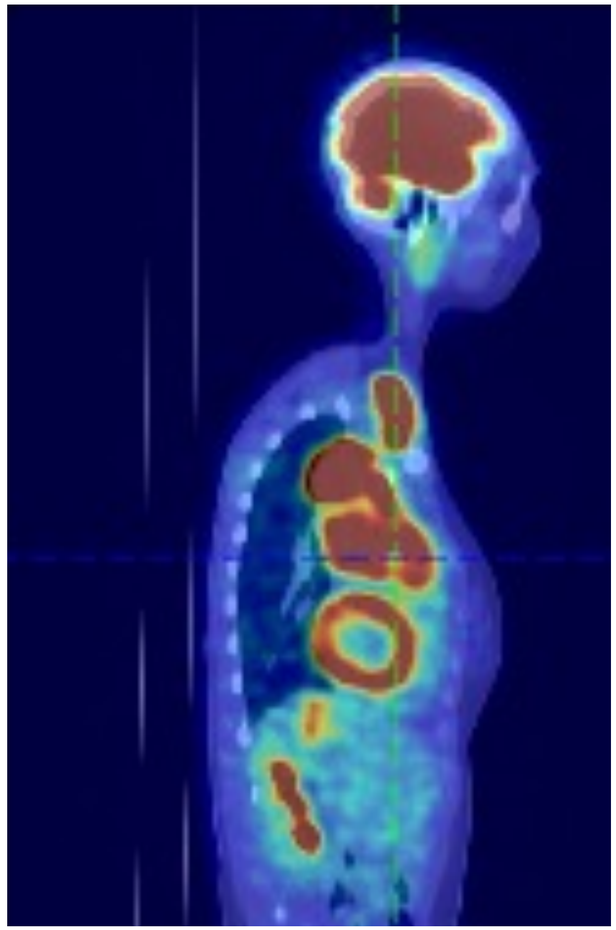
APR negativa; no comorbilità

Linfoma di Hodgkin, stadio IIA, bulky

RMC post 2 ABVD e ottima risposta morfologica alla TC dopo 4 ABVD







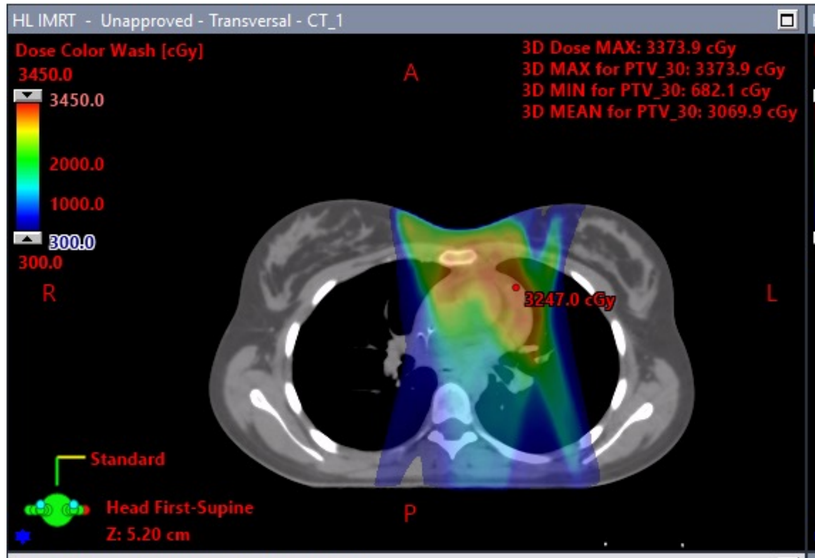
06-2019 TC/PET-FDG all'esordio

Come proseguiresti?

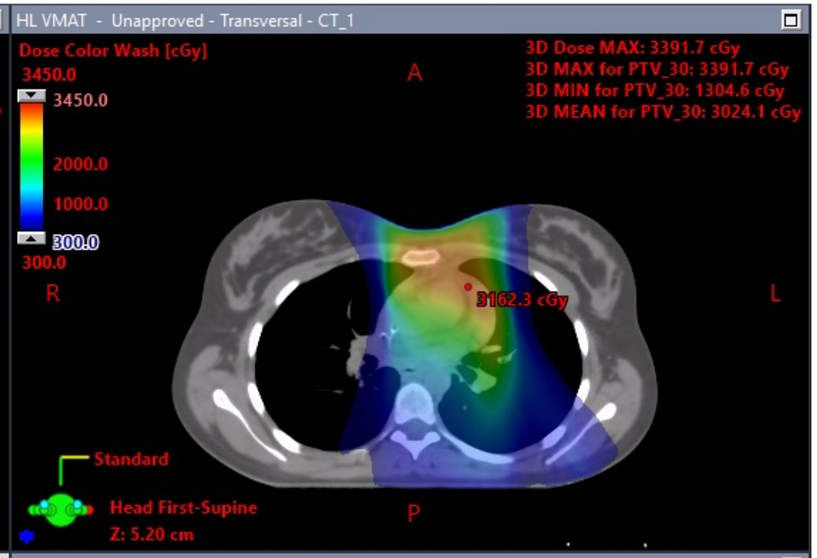
1. Radioterapia con fotoni
2. Radioterapia con protoni
3. Due ulteriori cicli ABVD
4. Nessun trattamento
5. Non mi espongo (☹)

Confronto tra piani di trattamento radioterapici

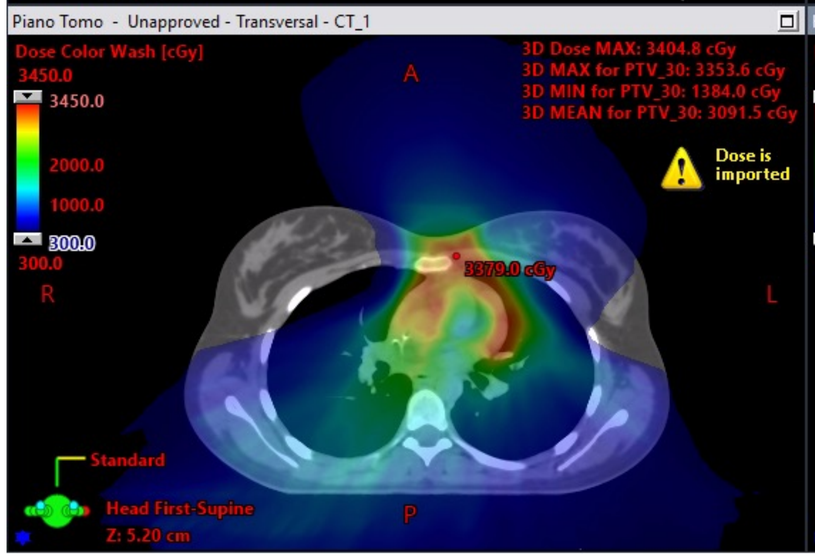
IMRT



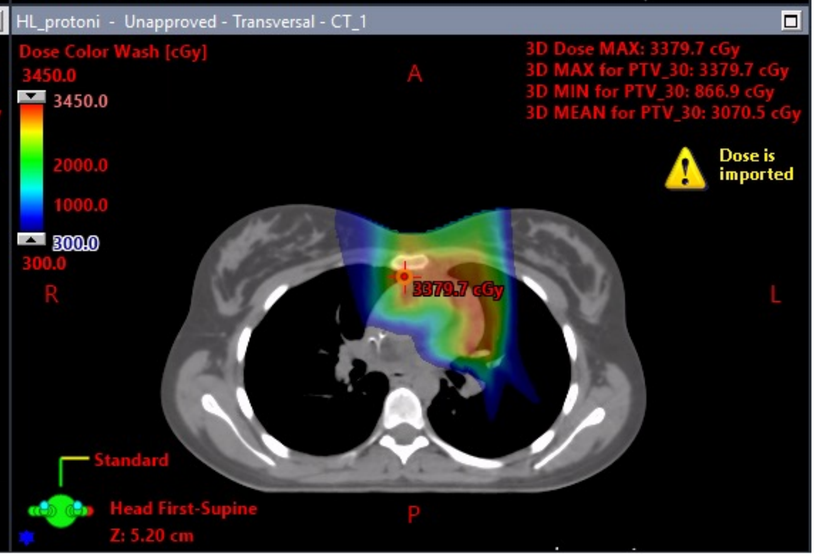
VMAT



Tomoterapia elicoidale



IMPT (terapia con protoni ad intensità modulata)

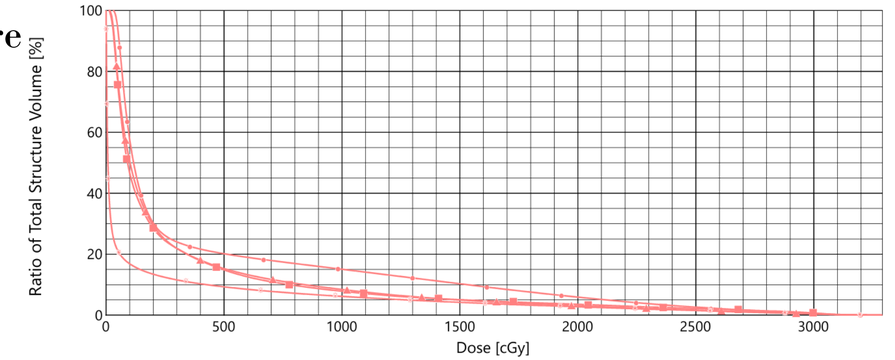


Obiettivi clinici

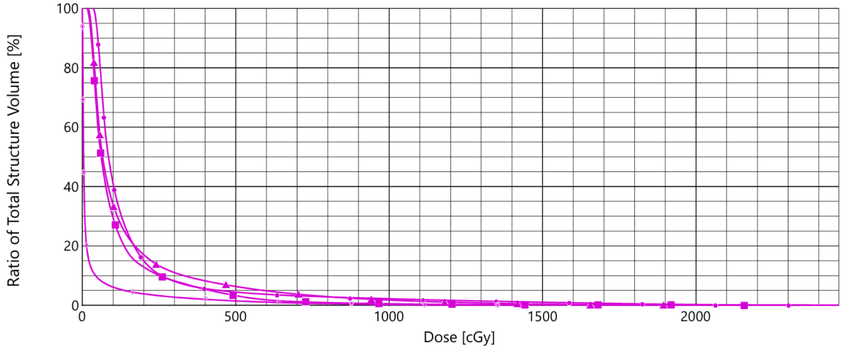
Plan			■ HL IMRT	▲ HL VMAT	● HL_Tomo	☼ HL_protoni
Total Dose			3000.0 cGy	3000.0 cGy	3404.8 cGy	3379.7 cGy
Clinical Goal Summary			2 0 15	2 0 15	1 0 16	0 0 17
Breast_L	P2	Dmean ≤ 500 cGy	246.64 cGy	274.89 cGy	344.67 cGy	164.10 cGy
Breast_R	P2	Dmean ≤ 500 cGy	108.50 cGy	94.96 cGy	138.63 cGy	100.58 cGy
Esophagus	P3	V 2000 cGy ≤ 30.0 %	38.42 %	36.75 %	36.45 %	27.80 %
Heart	P2	Dmean ≤ 500 cGy	300.15 cGy	303.08 cGy	416.87 cGy	170.37 cGy
LAD	P2	Dmax ≤ 2000 cGy	2063.24 cGy	2022.64 cGy	1962.06 cGy	1924.67 cGy
Lung_L	P2	V 500 cGy ≤ 55.0 %	41.81 %	38.88 %	52.27 %	23.83 %
	P2	V 1000 cGy ≤ 40.0 %	29.93 %	28.41 %	35.60 %	16.72 %
	P2	V 2000 cGy ≤ 30.0 %	17.52 %	16.31 %	14.81 %	9.21 %
	P2	Dmean ≤ 1000 cGy	817.04 cGy	748.52 cGy	869.21 cGy	454.87 cGy
Lung_R	P2	V 500 cGy ≤ 55.0 %	13.83 %	12.35 %	41.45 %	5.76 %
	P2	V 1000 cGy ≤ 40.0 %	8.34 %	6.79 %	21.42 %	3.68 %
	P2	V 2000 cGy ≤ 30.0 %	3.00 %	2.14 %	5.74 %	1.58 %
	P2	Dmean ≤ 1000 cGy	276.20 cGy	244.34 cGy	589.59 cGy	105.70 cGy
Spinal Cord	P2	Dmax ≤ 3000 cGy	2132.70 cGy	2281.44 cGy	1342.81 cGy	1630.65 cGy
Thyroid	P3	V 2500 cGy ≤ 62.5 %	30.83 %	27.44 %	20.15 %	17.78 %
Ventricle_L	P2	Dmean ≤ 500 cGy	113.53 cGy	145.68 cGy	154.56 cGy	30.20 cGy
Ventricle_R	P2	Dmean ≤ 500 cGy	176.54 cGy	200.40 cGy	214.25 cGy	77.51 cGy

Discreto rispetto dei limiti di dose con tutte le tecniche (a respiro libero ☹). Miglior performance per IMPT.

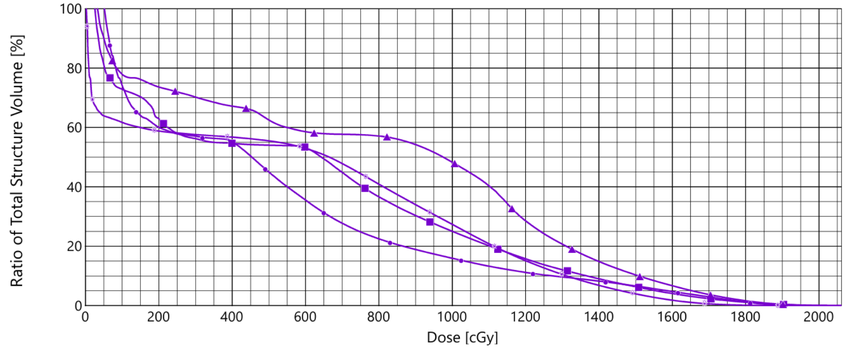
Cuore



Ventricolo sinistro



Arteria discendente anteriore sinistra



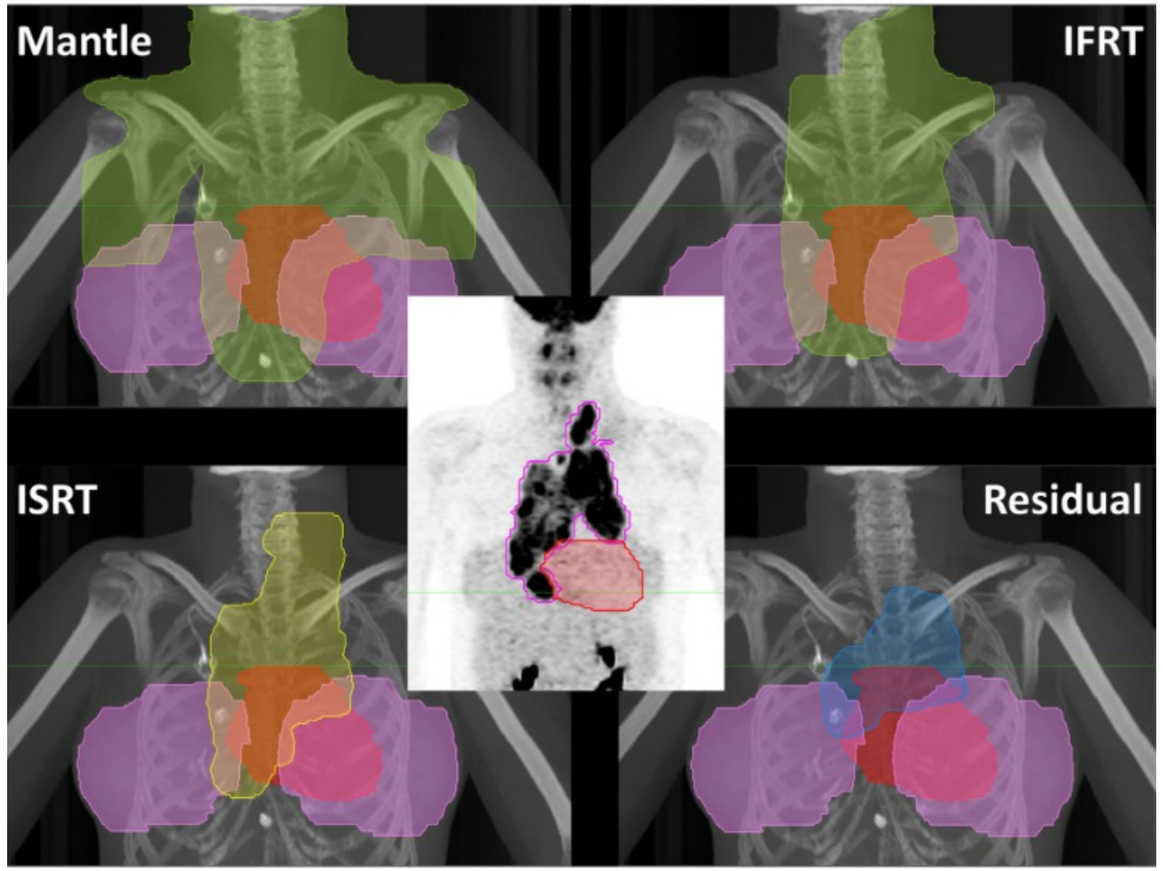
Multidisciplinarietà

Confronto tra tecnologie

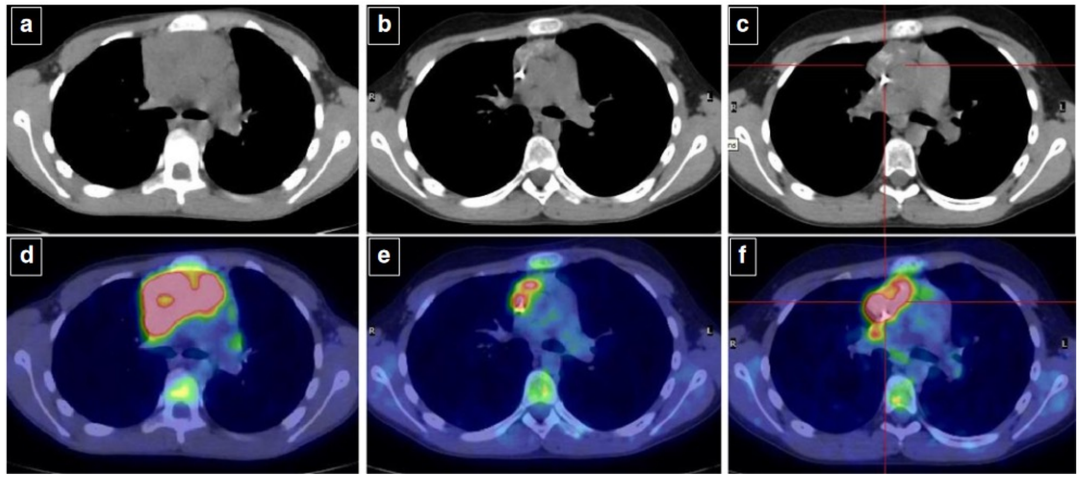
Follow-up

Multidisciplinarietà

Trattamento combinato



Strategie adattate al rischio e alla risposta



Radiology

CT, MRI, and FDG PET/CT in the Assessment of Lymph Node Involvement in Pediatric Hodgkin Lymphoma: An Expert Consensus Definition by an International Collaboration on Staging Evaluation and Response Criteria Harmonization for Children, Adolescent, and Young Adult Hodgkin Lymphoma (SEARCH for CAYAHL)

Multidisciplinarietà

RT è stata omessa nell'85% dei pazienti TL3-DECOPDac21

EuroNet-PHL-C2

0-25 anni

3 livelli di trattamento (TL) e riadattamento basato sulla risposta alla **chemioterapia di induzione (2 OEPA)**

- TL1 se ERA PET–, **COPDac x1** e **no RT** / se ERA PET+, **19.8 Gy ISRT**
- TL2 se ERA PET–, **COPDac x2** e **no RT** / se ERA PET+, DECOPDac x2 + **28.8 Gy INRT sedi LRA PET+**
- TL3 se ERA PET–, **DECOPDac x4** e **no RT** / se ERA PET+, DECOPDac x4 + **28.8 Gy INRT sedi LRA PET+**

ILROG
INTERNATIONAL LYMPHOMA RADIATION ONCOLOGY GROUP

18-60 anni; ISRT

- Stadio iniziale favorevole, 20 Gy
- Stadio iniziale sfavorevole, 30 Gy
- Minimo residuo metabolico (DS 4-5), 36 – 45 Gy

Mascarin M, risultato preliminare
Specht L et al., 10.1016/j.ijrobp.2013.05.005

Multidisciplinarietà

Confronto tra tecnologie

Follow-up

Confronto tra tecnologie

Fotone: energia senza massa

Maccanismi di danno:

- diretto
- indiretto

- RT guidata da immagini (IGRT)

  Surface-guided RT (SGRT)

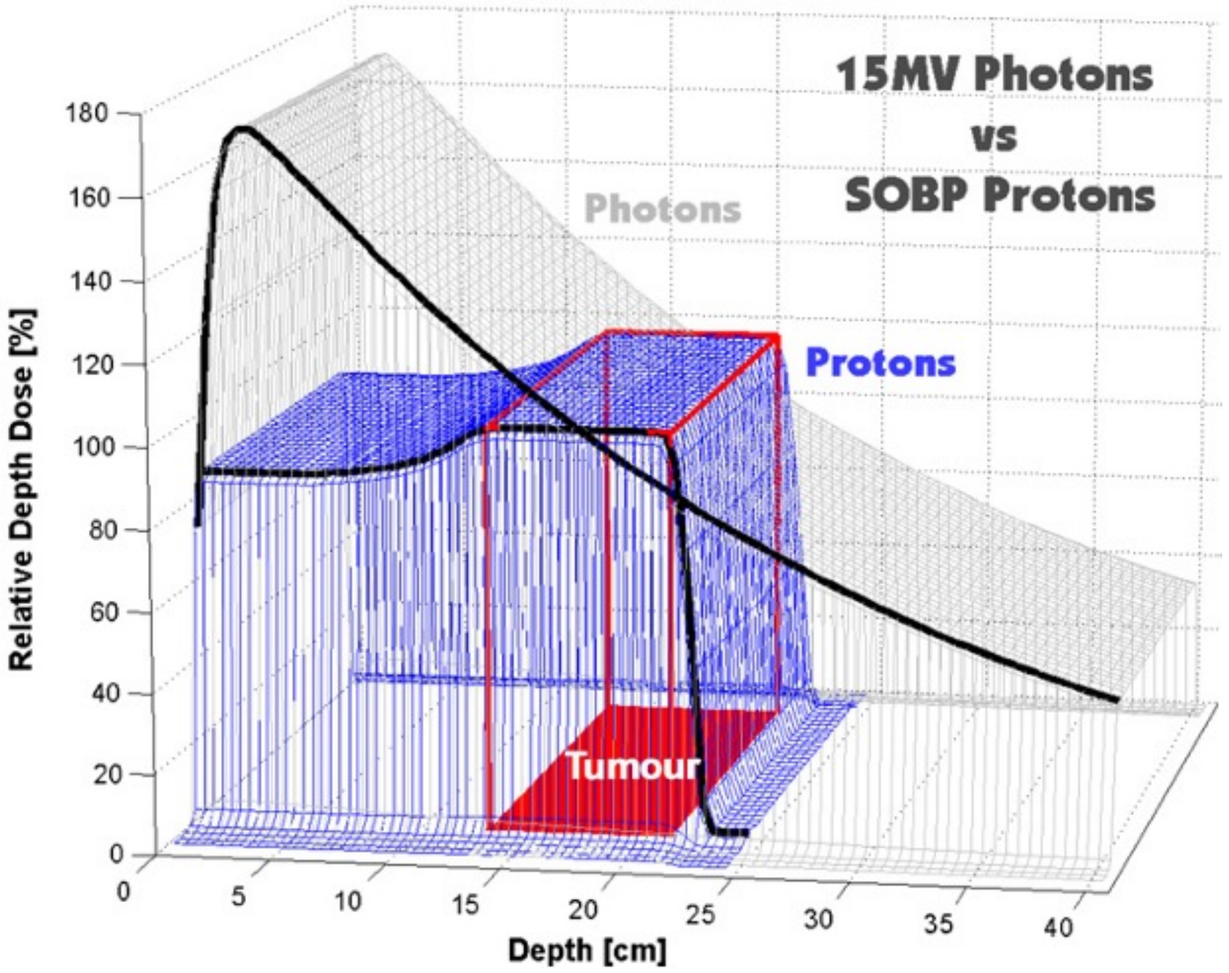
- 4D-CT

  RT a respiro trattenuto (DIBH)

- RT ad intensità modulata (IMRT)

  Terapia ad Arco Modulata Volumetricamente (VMAT)

Protonterapia



$m_p : m_e$

=

1836 : 1

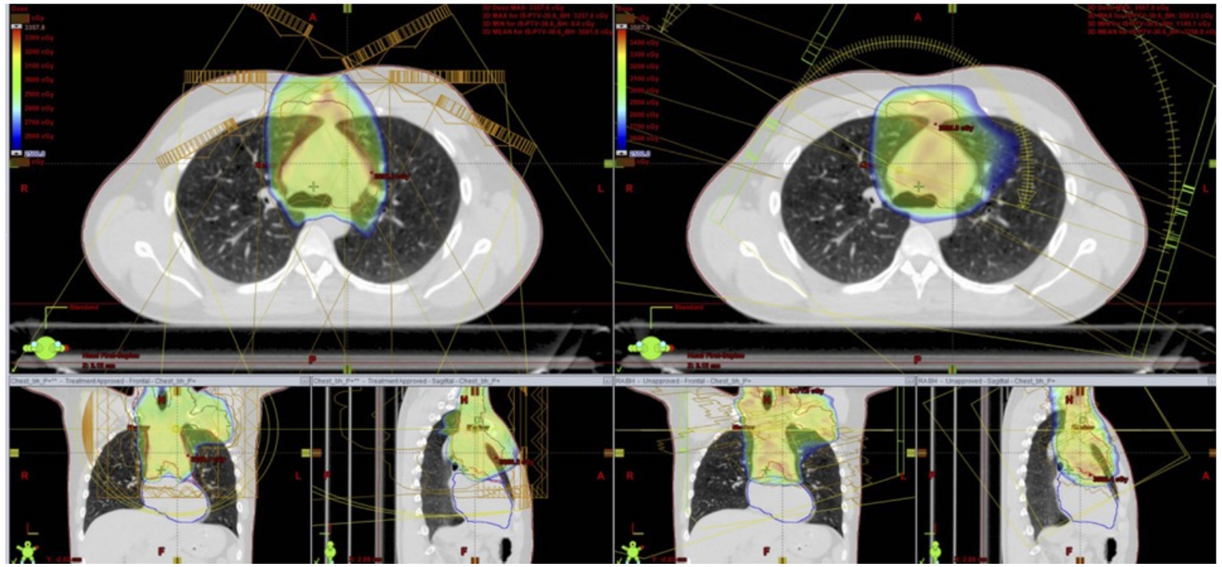
≡

5 kg : 2,7 g

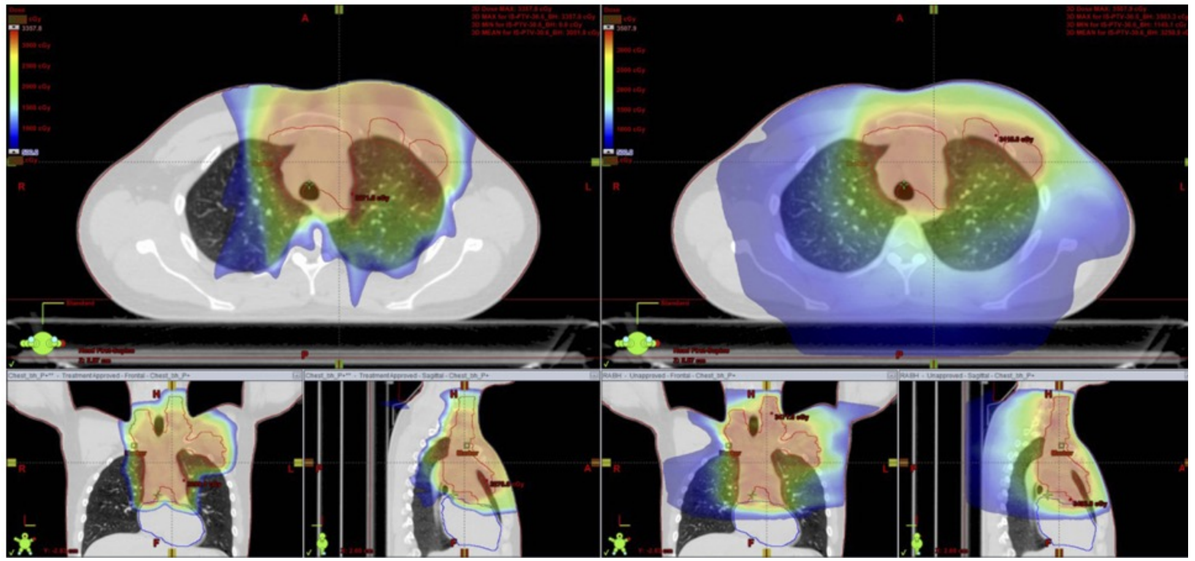
Confronto tra tecnologie - Protonterapia

Structures	Ideal	Optimize technique	Optimize field (consider field reduction)	Unacceptable	Avoid maximum dose landing in
Heart: left ventricle, coronary arteries, valves[39-41]	Mean < 5 Gy	Mean, 5-15 Gy	Mean > 15 Gy	Mean > 30 Gy	Coronary vessels
Breast (age dependent)*	Mean < 4 Gy	Mean, 4-15 Gy	Mean > 15 Gy	Mean > 30 Gy	Glandular tissue
Lung[38]	V_5 < 55%	V_5, 55-60%	—	V_5 > 60%	
	V_{20} < 30%	Mean, 10-13.5 Gy		Mean > 13.5 Gy	
	Mean < 10 Gy				
Thyroid[62]	V_{25} < 62.5%	V_{25} < 62.5%			Whole thyroid

Protoni (DS)+DIBH vs Fotoni (RapidArc)+DIBH



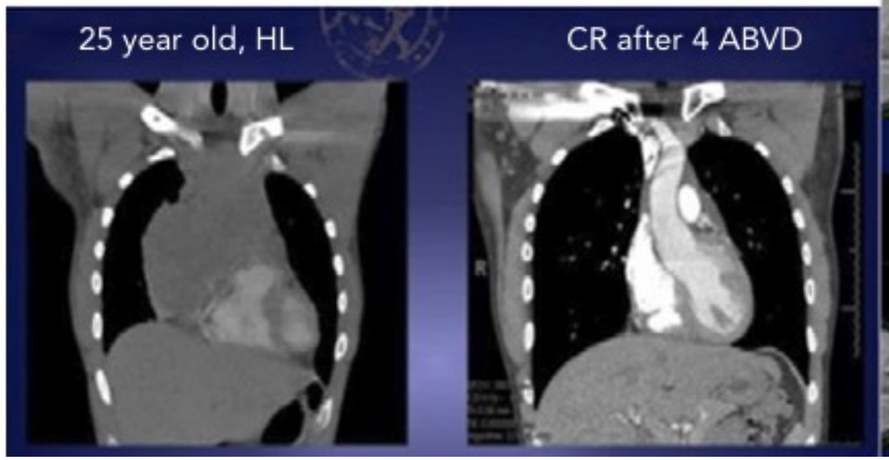
Protoni (DS) FB vs Fotoni (RapidArc) FB

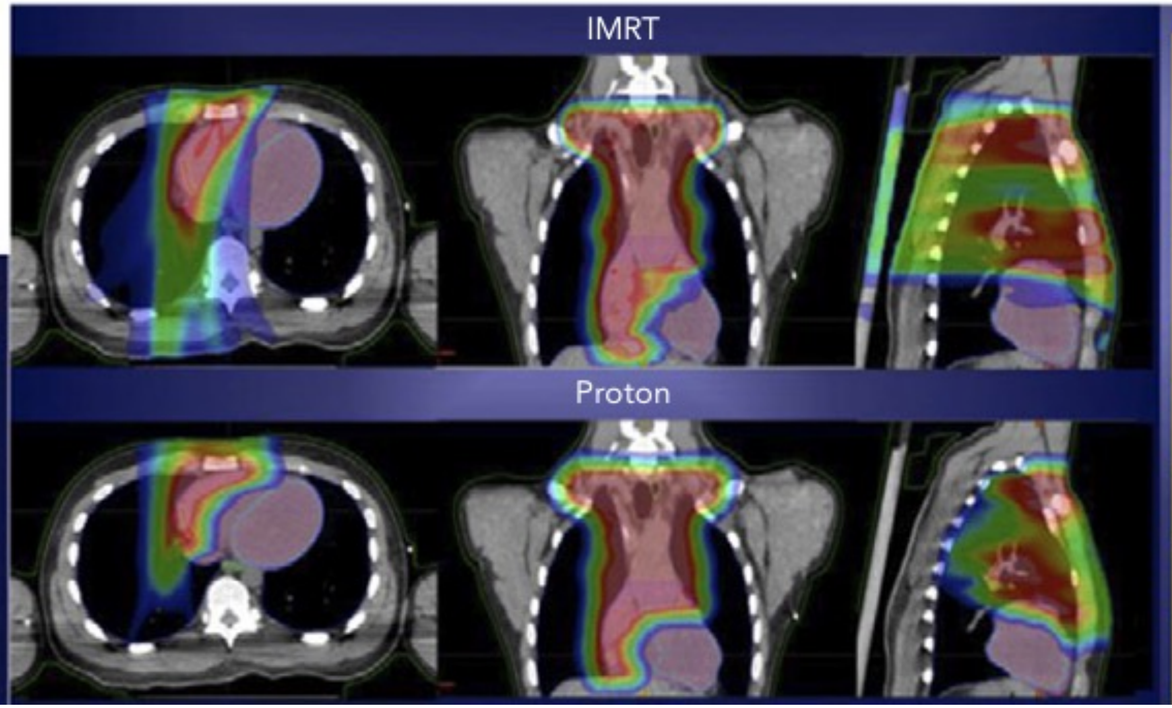


Dabaja BS et al., 10.1182/blood-2019-02-900738
Ricardi U et al., 10.2147/OTT.S220730

Confronto tra tecnologie - Protonterapia

1. Pazienti con malattia mediastinica che si estende al di sotto dell'origine dell'arteria coronaria principale sinistra e che è anteriore, posteriore o sul lato sinistro del cuore, **per ridurre la dose al cuore**





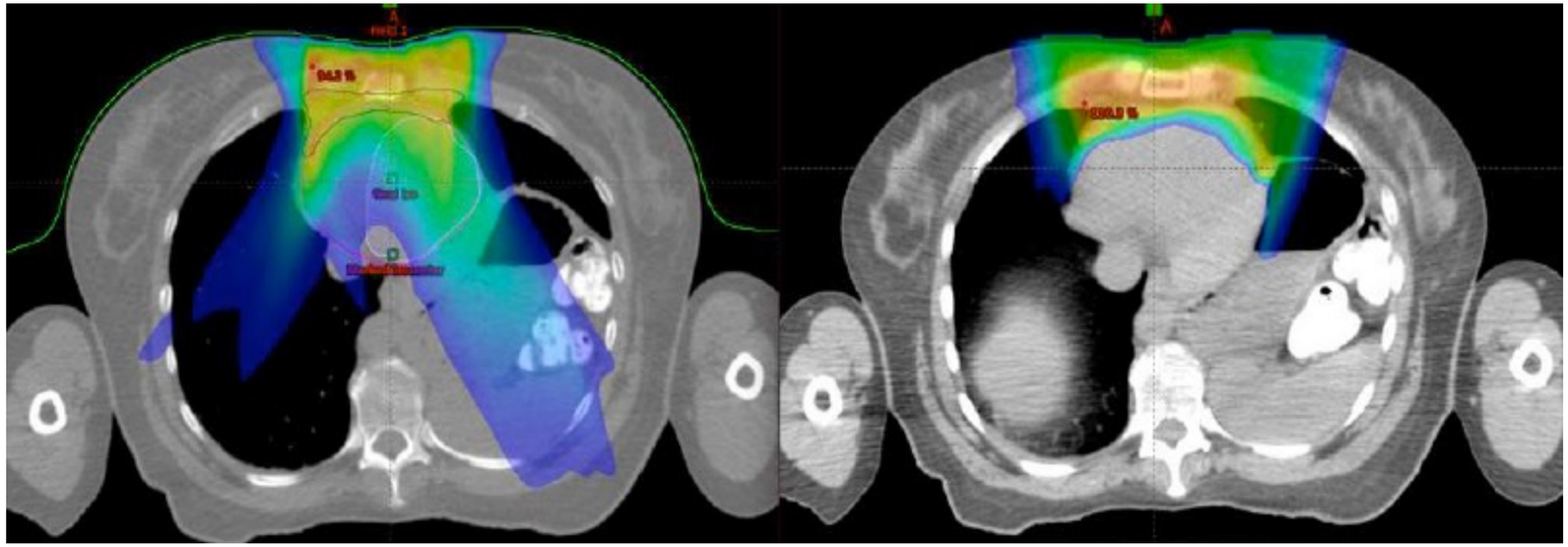
	IMRT/ mean dose	Proton/ mean dose
Esophagus	22.6	18.1
Heart	18.9	16.6
LAD	28.6	29.4
LV	7.8	4.5
RCA	31.2	31.3
Lungs	10,7	8.6
Body	6.8	2.1

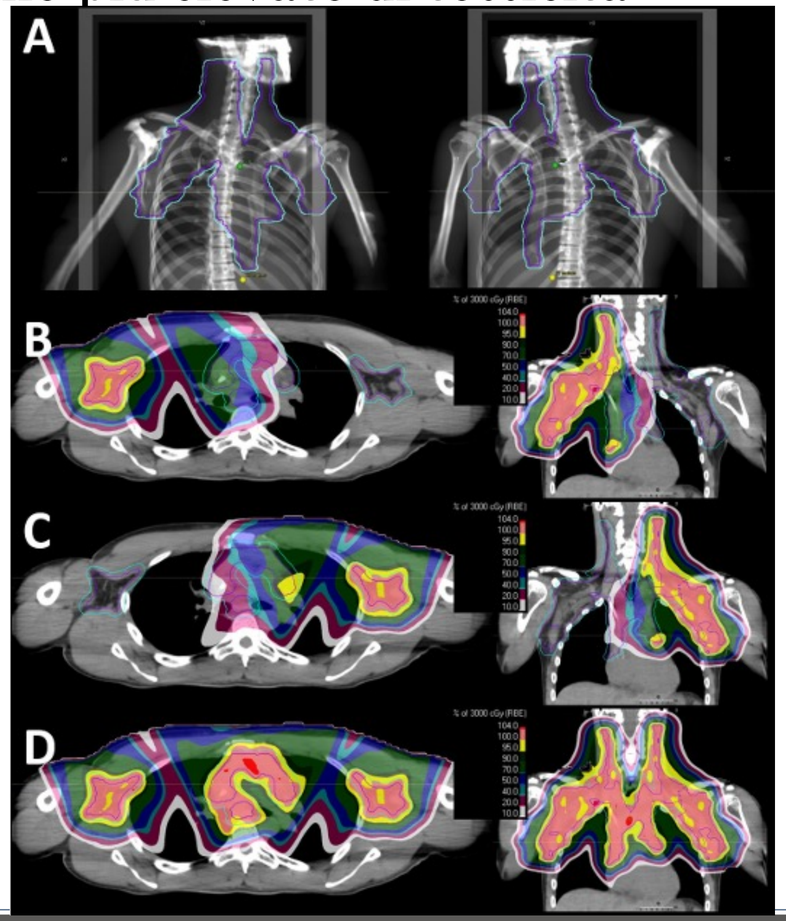
Dabaja BS et al., 10.1182/blood-2019-02-900738

Confronto tra tecnologie - Protonterapia

ILROG
INTERNATIONAL LYMPHOMA RADIATION ONCOLOGY GROUP

2. **Giovani donne**, per ridurre la dose al seno e il rischio di cancro al seno secondario
3. **Pazienti sottoposti a trattamenti intensivi** che presentano un rischio più elevato di tossicità correlata alle radiazioni



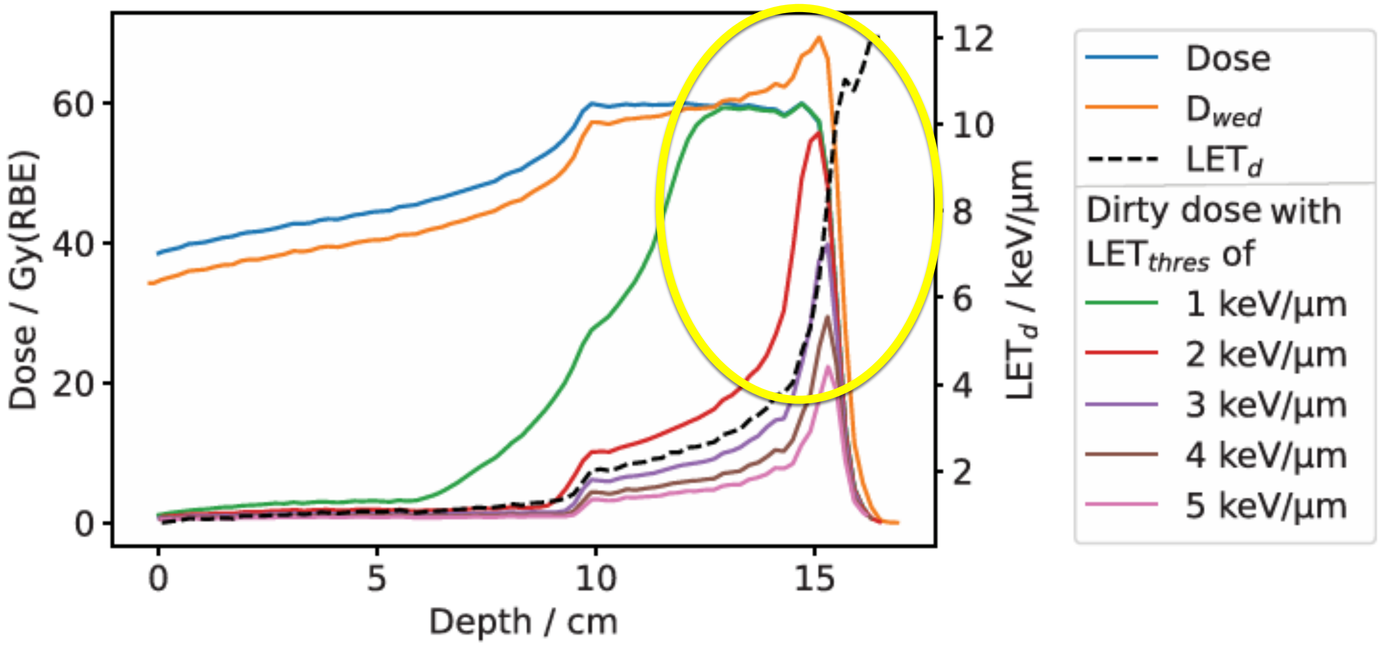


Dabaja BS et al., 10.1182/blood-2019-02-900738
Ebadi M et al., 10.3390/cancers16152736

La dose di radiazioni prescritta con protonterapia è:

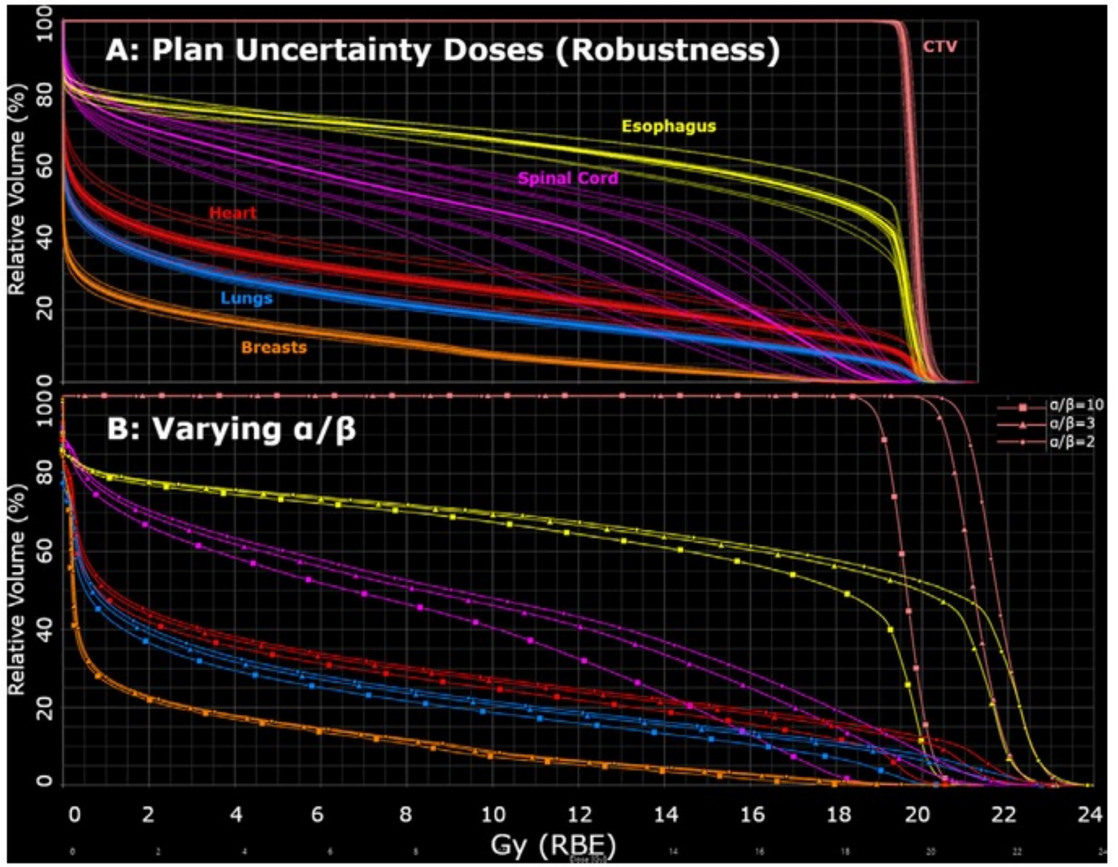
1. Superiore rispetto alla RT con fotoni
2. Modulata sulla base dello stadio di malattia
3. Uguale rispetto alla RT con fotoni
4. Sono un professionista coerente: non mi espongo neanche stavolta (☹ ☹ ☹)

Confronto tra tecnologie - Protonterapia



«Omnia venenum sunt: nec sine veneno quicquam existit. Dosis sola facit, ut venenum non fit.»

Paracelso, da Lühr A



Efficacia biologica relativa (RBE) del protone dipende dalla dose (totale e per frazione), dal tessuto, dall'endpoint e dal trasferimento lineare di energia (LET)

Heuchel L et al., 10.1002/mp.16809

Rechner LA et al., 10.1259/bjro.20230012

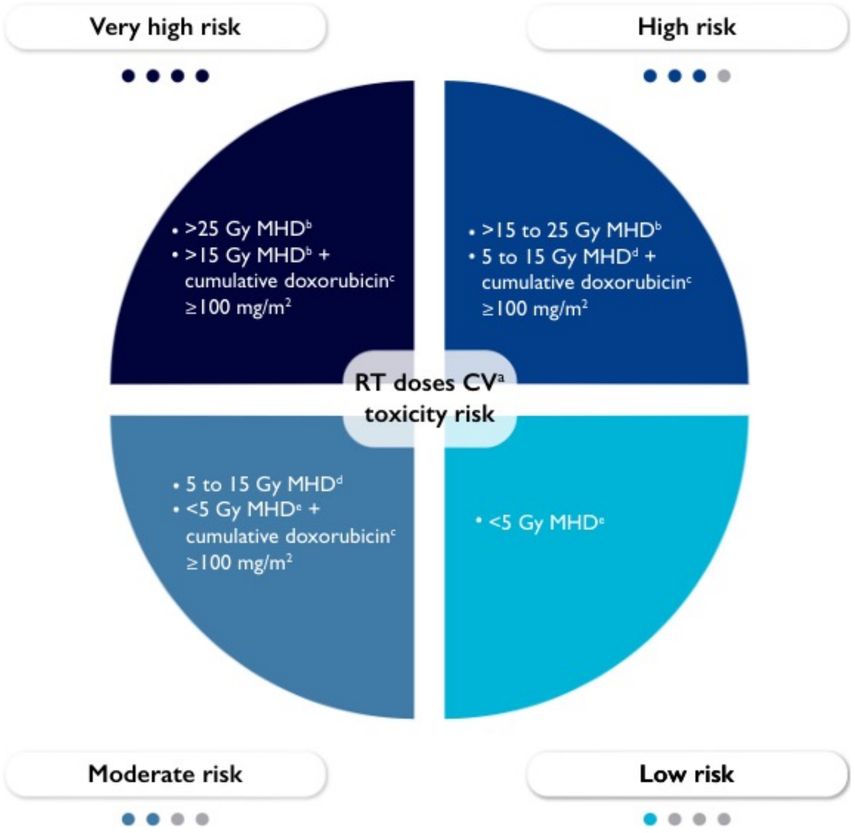
Multidisciplinarietà

Confronto tra tecnologie

Follow-up

Follow-up

Cardiotossicità



Secondi tumori

The Pediatric Proton and Photon Therapy Comparison Cohort: Study Design for a Multicenter Retrospective Cohort to Investigate Subsequent Cancers After Pediatric Radiation Therapy

Amy Berrington de González, DPhil,[a,*] Todd M. Gibson, PhD,[a] Choonsik Lee, PhD,[a] Paul S. Albert, PhD,[a] Keith T. Griffin, MS,[a] Cari Meinhold Kitahara, PhD,[a] Danping Liu, PhD,[a] Matthew M. Mille, PhD,[a] Jungwook Shin, PhD,[a] Benjamin V.M. Bajaj, MPH,[b] Tristin E. Flood, MS,[b] Sara L. Gallotto, MS,[b] Harald Paganetti, PhD,[b] Safia K. Ahmed, MD,[c] Bree R. Eaton, MD,[d] Daniel J. Indelicato, MD,[e] Sarah A. Milgrom, MD,[f] Joshua D. Palmer, MD,[g] Sujith Baliga, MD,[g] Matthew M. Poppe, MD,[h] Derek S. Tsang, MD,[i] Kenneth Wong, MD,[j,k] and Torunn I. Yock, MD[b]

Risk of secondary malignant neoplasms in children following proton therapy vs. photon therapy for primary CNS tumors: A systematic review and meta-analysis

Rituraj Upadhyay[1], Divya Yadav[2], Bhanu P. Venkatesulu[3], Raj Singh[4], Sujith Baliga[1], Raju R. Raval[1], Margot A. Lazow[1,5], Ralph Salloum[1,5], Maryam Fouladi[1,5], Elaine R. Mardis[5], Nicholas G. Zaorsky[6], Daniel M. Trifiletti[7], Arnold C. Paulino[2] and Joshua D. Palmer[1*]

Necessari risultati di studi di confronto a lungo termine per stabilire i potenziali rischi e benefici delle nuove tecnologie

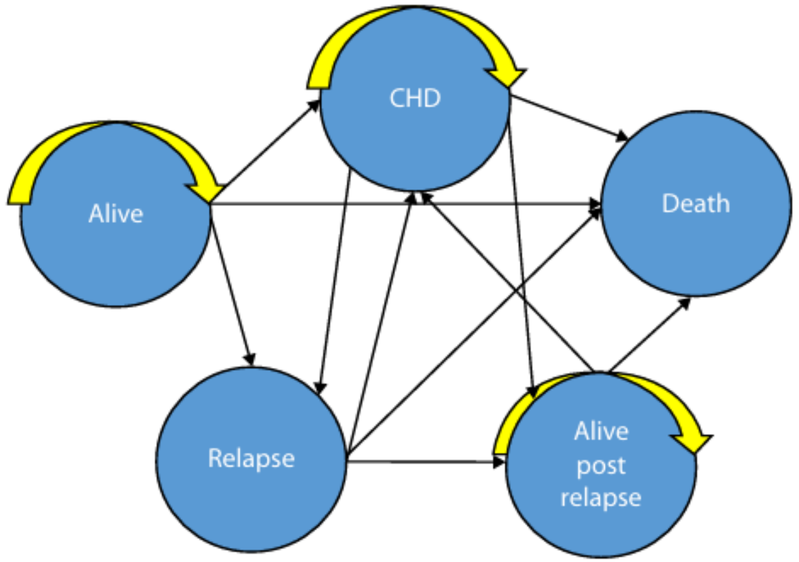
Follow-up

Costo-efficacia

International Journal of Radiation Oncology biology • physics

Establishing Cost-Effective Allocation of Proton Therapy for Patients With Mediastinal Hodgkin Lymphoma

Raymond B. Mailhot Vega, MD, MPH,* Homan Mohammadi, MD,† Samir I. Patel, MD,‡ Adam L. Holtzman, MD,* Natalie A. Lockney, MD,* James W. Lynch, MD,§ Manisha M. Bansal, MD,|| Xiaoying Liang, PhD,* William B. Slayton, MD,|| Susan K. Parsons, MD, MRP,¶ Bradford S. Hoppe, MD, MPH,# and Nancy P. Mendenhall, MD*



A model entrant could experience both relapse and CHD

Radiotherapy &Oncology

Life years lost attributable to late effects after radiotherapy for early stage Hodgkin lymphoma: The impact of proton therapy and/or deep inspiration breath hold

Laura Ann Rechner [a,b,*], Maja Vestmø Maraldo [a], Ivan Richter Vogelius [a], Xiaorong Ronald Zhu [c], Bouthaina Shbib Dabaja [d], Nils Patrik Brodin [e], Peter Meidahl Petersen [a], Lena Specht [a], Marianne Camille Aznar [b,f]

International Journal of Particle Therapy

Cost-Effectiveness of Proton Versus Photon Therapy for Medulloblastoma Using Updated Clinical Outcomes

Chonnipa Nantavithya (MD)[a,b], Anussara Prayongrat (MD, PhD)[a,b], Wasin Laohavinij (MD)[c], Piti Techavichit (MD)[d], Khomsak Srilanchakon (MD)[e], Nattawan Utoomprurkporn (MD)[f], Maythinee Chantadisai (MD)[g], Chaisiri Wanlapakorn (MD)[h], Kanjana Shotelersuk (MD)[a,b,*]

The Relative Costs of Proton and X-ray Radiation Therapy

clinical ONCOLOGY

M. Goitein*, M. Jermann†

Follow-up

Costo-efficacia
Italia

Livelli essenziali di assistenza

«Pazienti con una delle forme tumorali sottoelencate, in **assenza di malattia metastatica**, in cui siano presenti tutte le seguenti condizioni:

a) il trattamento abbia finalità **radicali curative**;
b) PS: **0-2 ECOG**;
c) non siano presenti concomitanti malattie o comorbidità invalidanti che riducano in maniera significativa l'**attesa di vita**:

(...) 8) tumori solidi **pediatrici**;

10) recidive che richiedono il **ritrattamento** in un'area già precedentemente sottoposta a RT.»

Gazzetta Ufficiale, DPCM 12 gennaio 2017, nota 97

Multidisciplinarietà

Scelte condivise

Confronto tra tecnologie

Maggior consapevolezza

Follow-up

Nuove sfide

Grazie per l'attenzione