

Interconfronti multicentrici di piani di trattamento per SBRT

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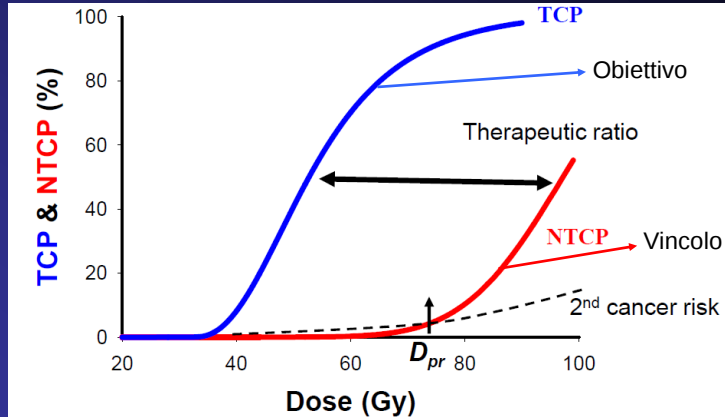
Gruppo di lavoro SBRT AIFM



Gruppo di lavoro SBRT

- Survey della situazione nazionale
- Contribuire alla formazione dei fisici in SBRT
- Condividere esperienza
- Creare rete per ricerca
- Confrontare tecniche di irraggiamento diverse

Problematiche planning per SBRT



J Uzan, and A E Nahum, *The British Journal of Radiology*, 85 (2012), 1279–1286

- 1) La valutazione di un piano di trattamento potrebbe fornire una soluzione non ottimale nel processo di ottimizzazione
- 2) Gestione della Dose al target: dose minima (95-98-100% Vol) e dose massima

Problematiche planning per SBRT

[illegible]

Gestione dell'ottimizzazione Radiobiologica



Nuove tecniche di irraggiamento pongono nuovi problemi di planning (archi-pitch-fasci).

Progetto di interconfronto dosimetrico nazionale dei piani di trattamento

Scopo:

- i) Condividere vincoli di dose e obiettivi di planning
- ii) **Confrontare distribuzioni di dose in un contesto nazionale reale: macchine esperienze e TPS diversi**
- iii) Contribuire alla diffusione di tipologie di trattamento nuove

Progetto di interconfronto dosimetrico nazionale dei piani di trattamento

- Individuare dei casi di trattamenti reali già effettuati.
- Fornire ai partecipanti:
 - i) Immagini TC (e curva di calibrazione)
 - ii) Strutture
 - iii) Protocollo per piano di trattamento:
 - iv) Constraint di dose per organi a rischio
 - v) Dose per target

Progetto di interconfronto dosimetrico nazionale dei piani di trattamento

3 progetti chiusi

Fegato (14 centri partecipanti)

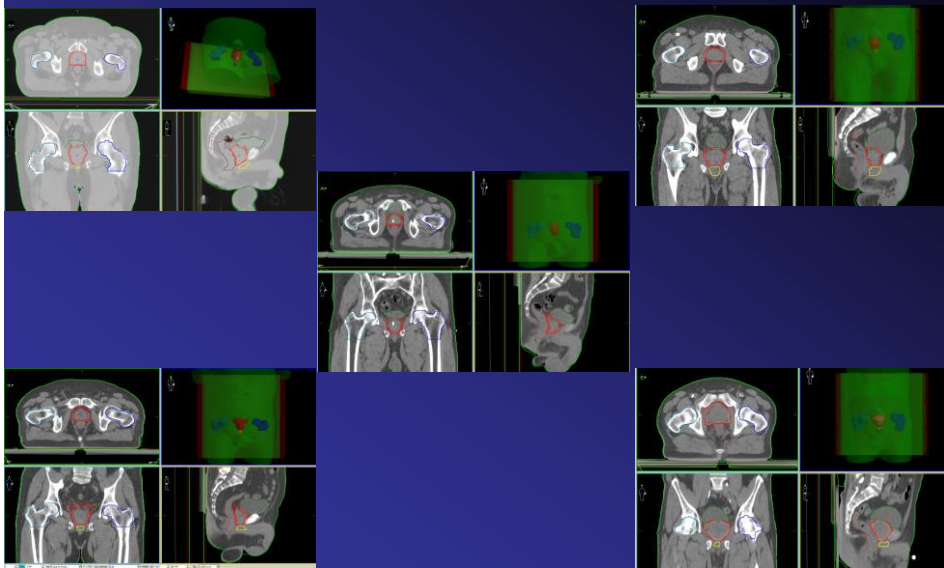
Prostata (14 centri partecipanti)

Polmone (25 centri partecipanti)

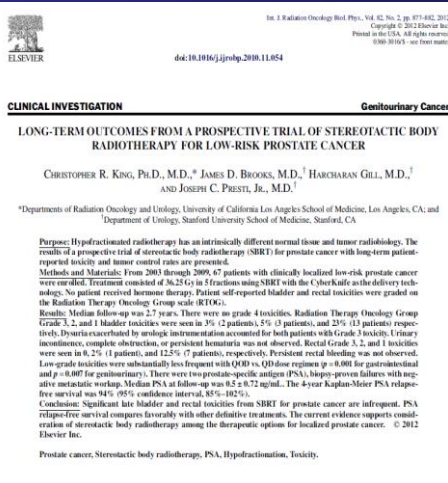
1 progetto in elaborazione

Metastasi ossee

Progetto prostata: TC



Progetto prostata: protocollo



Prescrizione di Dose:

7.25x5 frazioni= 36.25 Gy

Normalizzata 90% dose al 95% PTV

Retto:

V18<50%

V29<20%

V32<10%

V36<5%

Vescica:

V18<40%

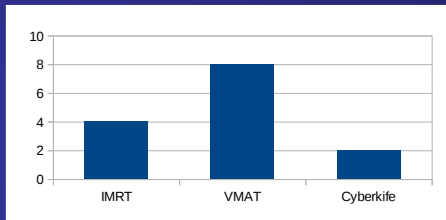
V36<10%

Teste femorali:

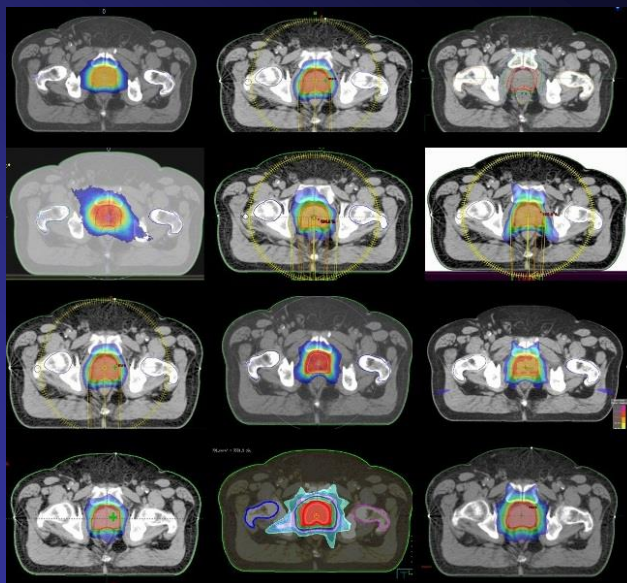
V14<5%

Progetto prostata: partecipanti

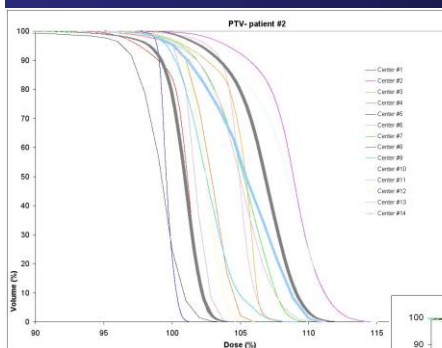
	1	2	3	4	5	6	7	8	9	10	11	13	12	14
Treatment Planning	Eclipse 11.0	Eclipse 10.0	Eclipse 10.0	Eclipse 8.6	Masterplan 4.3	Eclipse 8.6	Eclipse 10.0	iPlan RT	Pinnacle 9.2	Monaco 3.3	Monaco 3.1	Multiplan 4.6	Eclipse 10.0	Multiplan 4.6
Beam Arrangement	VMAT 2 arcs	VMAT 2 arcs	VMAT 2 arcs	VMAT 2 arcs	IMRT 8 fields	IMRT 7 fields	VMAT 2 arcs	IMRT 7 fields	IMRT 7 fields	VMAT 2 arcs	VMAT 1 arc	190 beams	VMAT 1 arc	190 beams
MLC thickness	2.5 mm	5 mm	2.5 mm	5 mm	4 mm	10 mm	5 mm	3 mm	5 mm	4 mm	10 mm	Iris/cones	2.5 mm	Iris/cones
SBRT treatments	> 100	> 100	< 100	> 100	< 100	none	< 100	> 100	> 100	> 100	< 100	> 100	> 100	> 100



Distribuzioni di dose



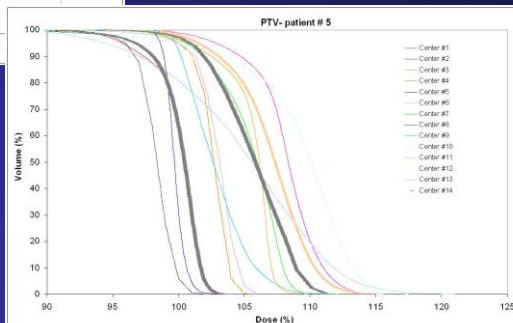
DVH-PTV



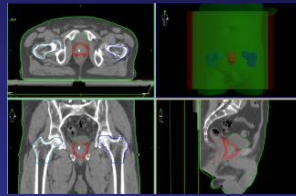
CT pt#2



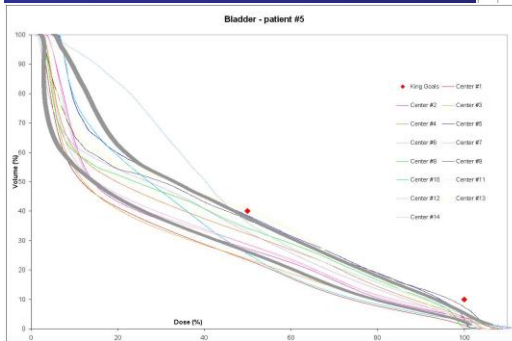
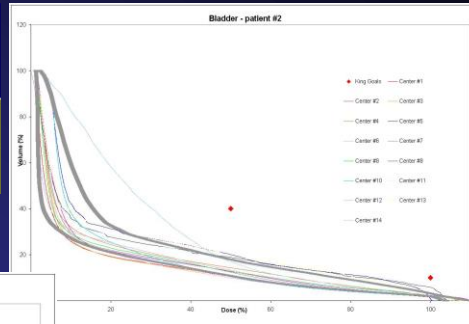
CT pt#5



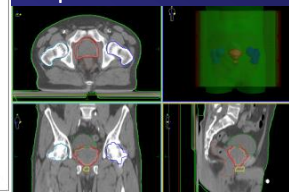
DVH-Vescica



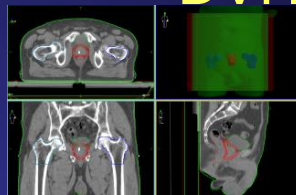
CT pt#2



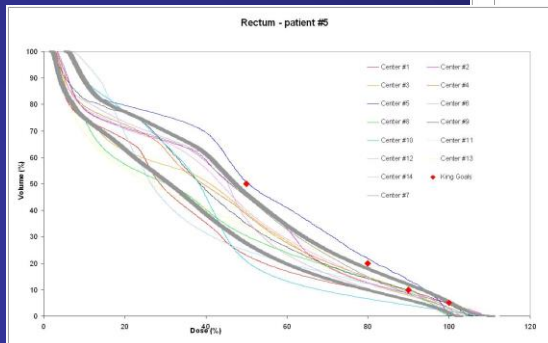
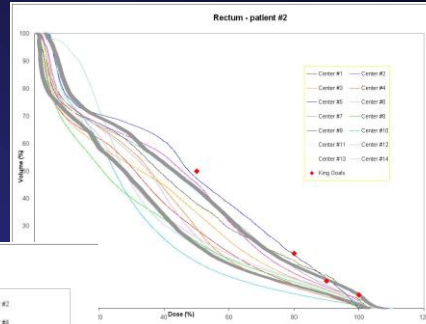
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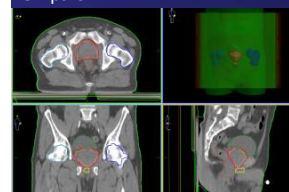
DVH-Retto



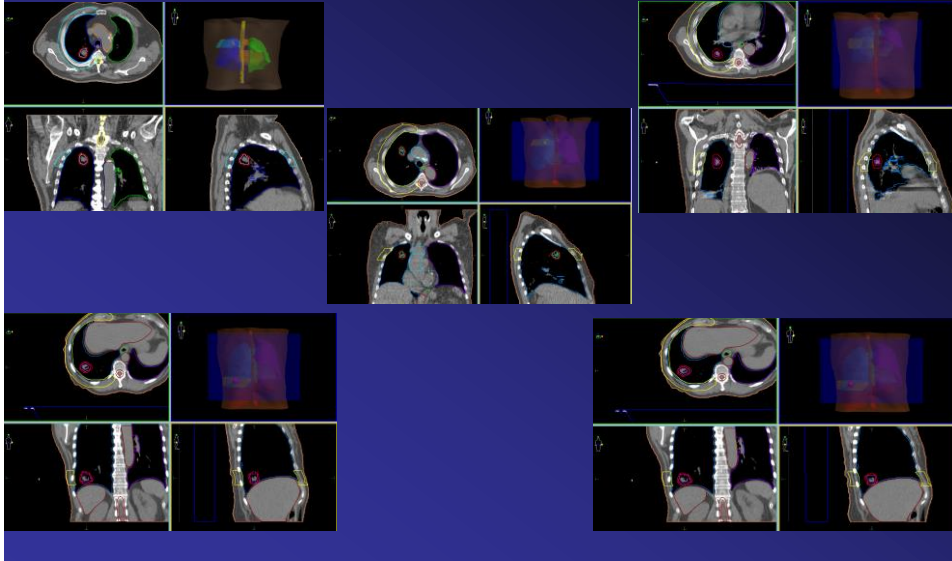
CT pt#2



CT pt#5



Progetto Polmone TC



Progetto polmone: protocollo

Constraints per organi a rischio

Medical Physics, Vol. 27, No. 8, August 2010

TABLE III. Summary of suggested dose constraints for various critical organs. Note that for serial tissues, the volume-dose constraints are given in terms of the critical maximum tissue volume that should receive a dose equal to or greater than the indicated threshold dose for the given number of fractions used. For parallel tissues, the volume-dose constraints are based on a critical minimum volume of tissue that should receive a dose equal to or less than the indicated threshold dose for the given number of fractions used.

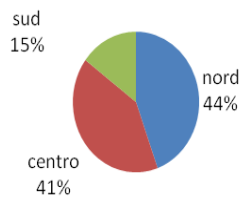
Serial tissue	Max critical volume above threshold	One fraction		Three fractions		Five fractions		End point (a Grade)
		Threshold dose (Gy)	Max point dose (Gy) ^a	Threshold dose (Gy)	Max point dose (Gy) ^a	Threshold dose (Gy)	Max point dose (Gy) ^a	
Optic pathway	<0.2 cc	8	10	15.3 (5.1 Gy/fx)	17.4 (5.8 Gy/fx)	23 (4.6 Gy/fx)	25 (5 Gy/fx)	Neuritis
Cochlea			9		17.1 (5.7 Gy/fx)		25 (5 Gy/fx)	Neuritis
Brainstem (not medulla)	<0.5 cc	10	15	18 (6 Gy/fx)	23.1 (7.7 Gy/fx)	23 (4.6 Gy/fx)	31 (6.2 Gy/fx)	Hearing loss
Spinal cord and medulla	<0.35 cc	10	14	18 (6 Gy/fx)	21.9 (7.3 Gy/fx)	23 (4.6 Gy/fx)	30 (6 Gy/fx)	Cranial neuropathy
Spinal cord subvolume (5–6 mm above and below level treated per Rx)	<1.2 cc	7		12.5 (4.1 Gy/fx)		14.5 (2.9 Gy/fx)		Myelitis
Cardiac apex	<10% of subvolume	10	14	18 (6 Gy/fx)	21.9 (7.3 Gy/fx)	23 (4.6 Gy/fx)	30 (6 Gy/fx)	Myelitis
Small pleura	<5 cc	14	16	21.9 (7.3 Gy/fx)	24 (8 Gy/fx)	30 (6 Gy/fx)	32 (6.4 Gy/fx)	Neuritis
Esophagus	<5 cc	11.9	15.4	17.7 (5.9 Gy/fx)	25.2 (8.4 Gy/fx)	19.5 (3.9 Gy/fx)	35 (7 Gy/fx)	Neuropathy
Brachial plexus	<3 cc	14	17.5	20.4 (6.8 Gy/fx)	24 (8 Gy/fx)	27 (5.4 Gy/fx)	30.5 (6.1 Gy/fx)	Neuropathy
Heart/pericardium	<15 cc	16	22	24 (8 Gy/fx)	30 (10 Gy/fx)	32 (6.4 Gy/fx)	38 (7.6 Gy/fx)	Pericarditis
Great vessels	<10 cc	31	37	39 (13 Gy/fx)	45 (15 Gy/fx)	47 (9.4 Gy/fx)	53 (10.6 Gy/fx)	Aneurysm
Trachea and large bronchi	<4 cc	10.5	20.2	15 (5 Gy/fx)	30 (10 Gy/fx)	16.5 (3.3 Gy/fx)	40 (8 Gy/fx)	Stenosis/fibrosis
Bronchio-vascular bundles	<0.5 cc	12.4	13.3	19.9 (6.6 Gy/fx)	23.1 (7.7 Gy/fx)	21 (4.2 Gy/fx)	33 (6.6 Gy/fx)	Stenosis with infection
Ribs	<1 cc	22	30	28.8 (9.6 Gy/fx)	36.9 (12.3 Gy/fx)	35 (7 Gy/fx)	43 (8.6 Gy/fx)	Pain or fracture
Skin	<10 cc	23	26	30 (10 Gy/fx)	33 (11 Gy/fx)	36.5 (7.3 Gy/fx)	39.5 (7.9 Gy/fx)	Ulceration
Stomach	<10 cc	11.2	12.4	16.5 (5.5 Gy/fx)	22.2 (7.4 Gy/fx)	18 (3.6 Gy/fx)	32 (6.4 Gy/fx)	Ulceration/fibrosis
Diaphragm	<5 cc	11.2	12.4	16.5 (5.5 Gy/fx)	22.2 (7.4 Gy/fx)	18 (3.6 Gy/fx)	32 (6.4 Gy/fx)	Ulceration
	<10 cc	9		11.4 (3.8 Gy/fx)		12.5 (2.5 Gy/fx)		
Jejunum/ileum ^b	<5 cc	11.9	15.4	17.7 (5.9 Gy/fx)	25.2 (8.4 Gy/fx)	19.5 (3.9 Gy/fx)	35 (7 Gy/fx)	Enteritis
Colon ^c	<20 cc	14.3	18.4	24 (8 Gy/fx)	28.2 (9.4 Gy/fx)	25 (5 Gy/fx)	38 (7.6 Gy/fx)	Obstruction
Rectum ^d	<20 cc	14.3	18.4	24 (8 Gy/fx)	28.2 (9.4 Gy/fx)	25 (5 Gy/fx)	38 (7.6 Gy/fx)	Cystitis/fibrosis
Bladder wall	<15 cc	11.4	18.4	16.8 (5.6 Gy/fx)	28.2 (9.4 Gy/fx)	18.3 (3.6 Gy/fx)	38 (7.6 Gy/fx)	Cystitis/fibrosis
Prostate bulb	<3 cc	14	34	21.9 (7.3 Gy/fx)	42 (14 Gy/fx)	30 (6 Gy/fx)	50 (10 Gy/fx)	Impotence
Penile bulb								
Female genitalia (right and left)	<10 cc	14		21.9 (7.3 Gy/fx)		30 (6 Gy/fx)		Necrosis
Rectal bulb/vascular trunk	<2/3 volume	10.6	18.6 (6.2 Gy/fx)			23 (4.6 Gy/fx)		Malignant hyperplasia

Prescrizione di Dose

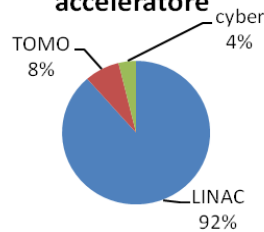
18 Gyx3 Frazioni
54 Gy su PTV

Progetto Polmone: Partecipanti

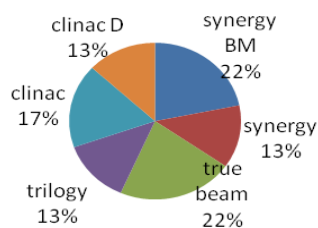
centri partecipanti



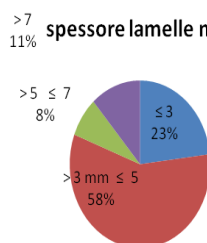
acceleratore



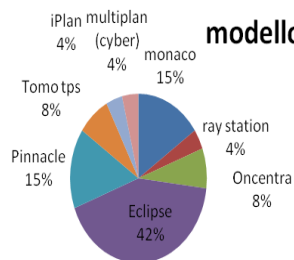
modello linac



spessore lamelle mm

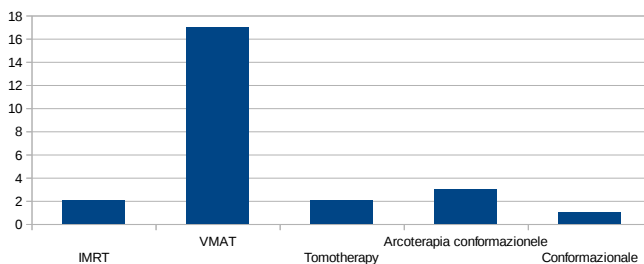
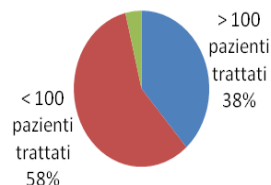


modello tps

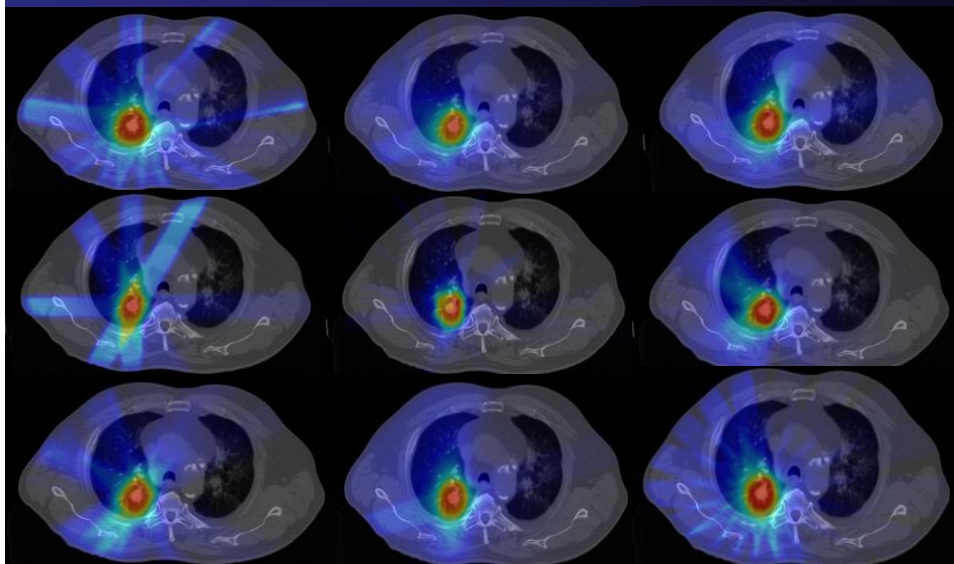


**nessun
paziente**

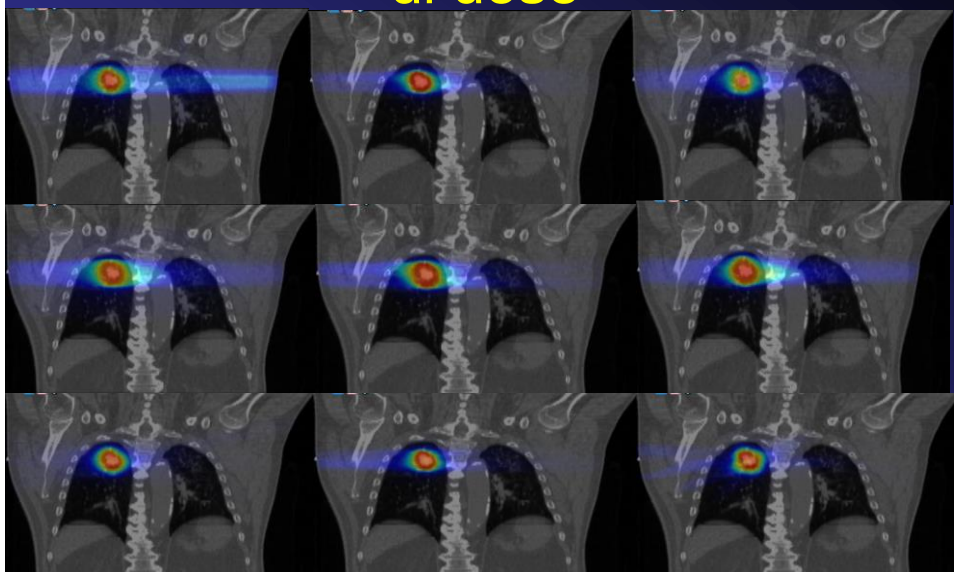
esperienza sbrr lung



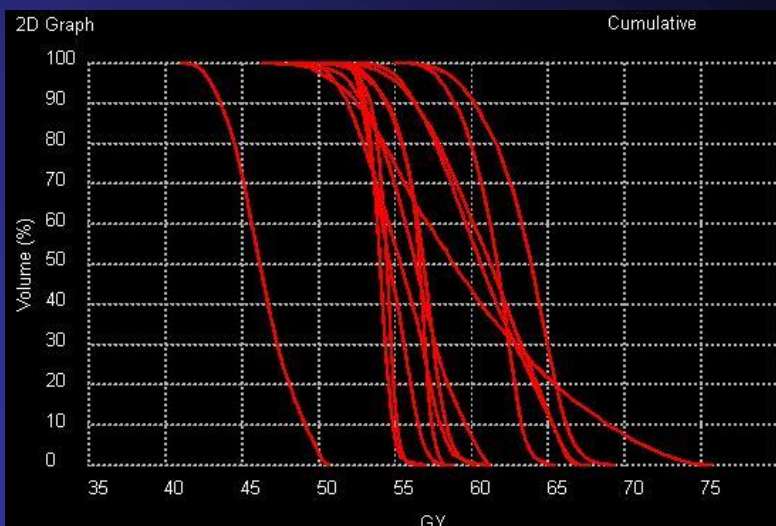
Progetto polmone: distribuzioni di dose



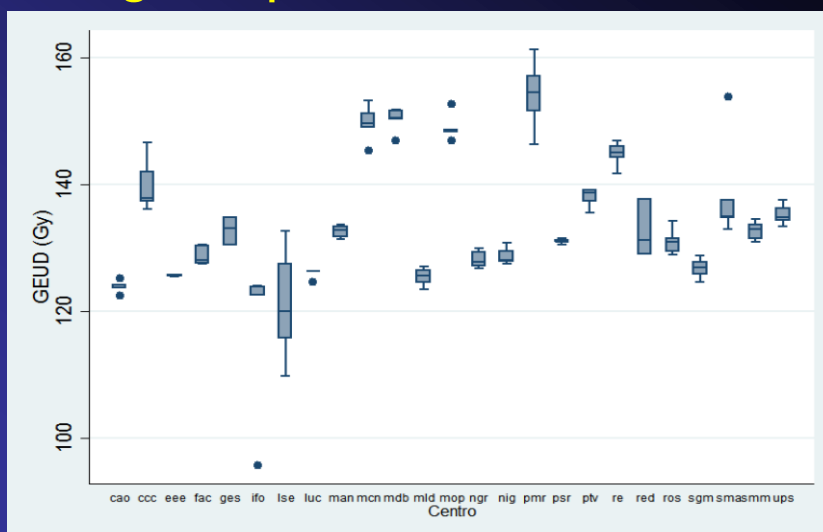
Progetto polmone: distribuzioni di dose



Progetto Polmone DVH PTV



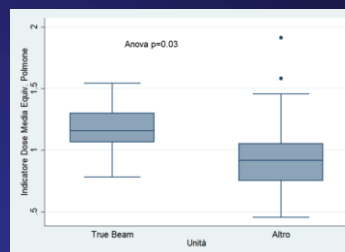
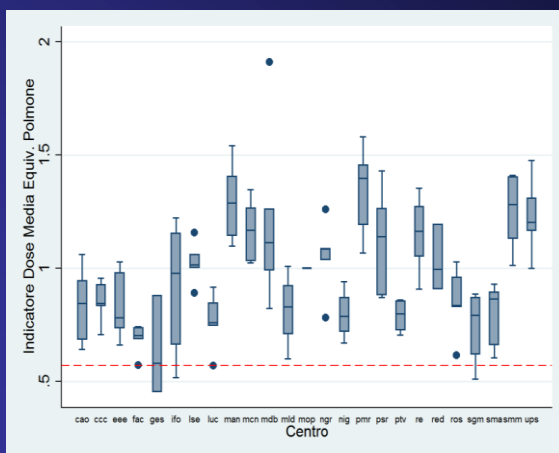
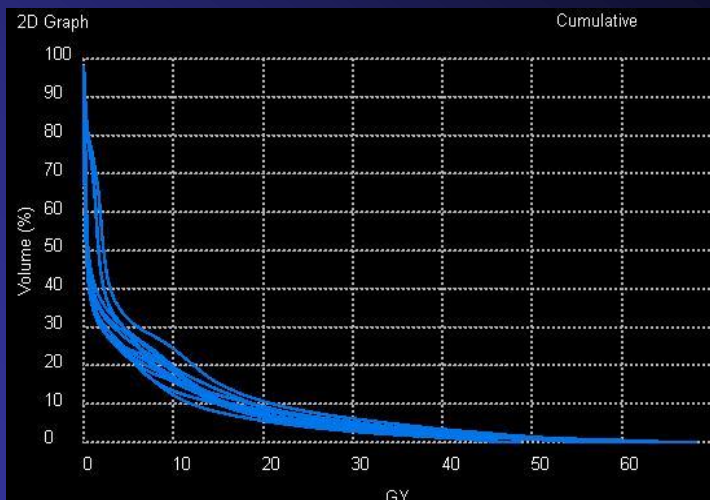
Progetto polmone DVH PTV



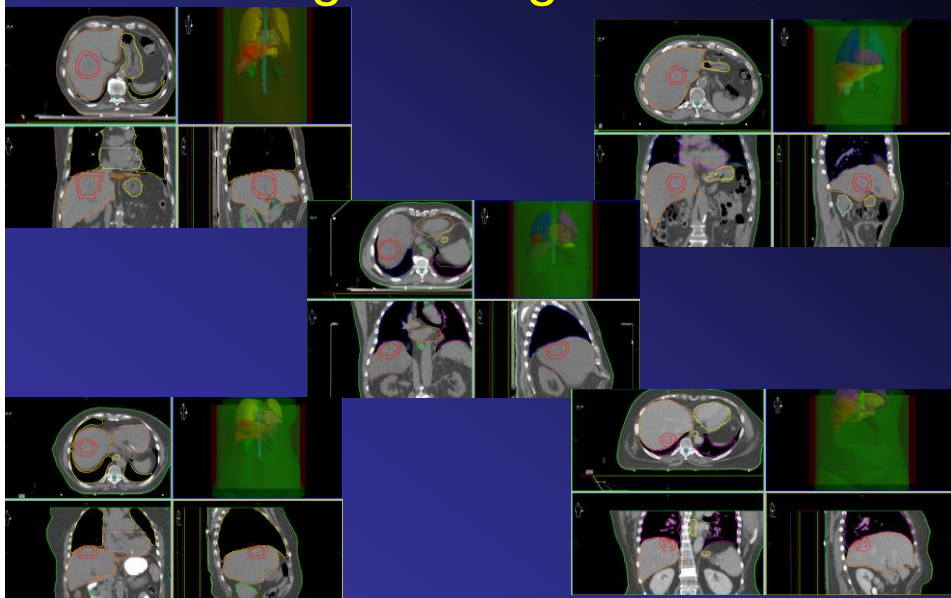
$$EUD = \left(\sum_{i=1}^n (v_i D_i^a) \right)^{\frac{1}{a}}$$

a=-10

Progetto Polmone DVH polmone



Progetto Fegato: TC



Progetto Fegato: protocollo

	Dose/fraction	Number fractions	Dose
Standard dose	25Gy	3	75 Gy
Dose reduction 10%	22.5 Gy	3	67.5 Gy
Dose reduction 20%	20. 63 Gy	3	61.89 Gy
Dose reduction 30%	18.75 Gy	3	56.25 Gy

Riduzione di dose per rispettare
i vincoli sugli OAR

Multi-Institutional Phase I/II Trial of Stereotactic Body Radiation Therapy for Liver Metastases

Kyle E. Rusthoven, Brian D. Kavanagh, Higinia Cardenas, Volker W. Stieber, Stuart H. Burri, Steven J. Feigenberg,
Mark A. Child, Thomas J. Pugh, Wilbur Franklin, Madeline Kane, Laurie E. Gaspar, and Tracey E. Scheffer

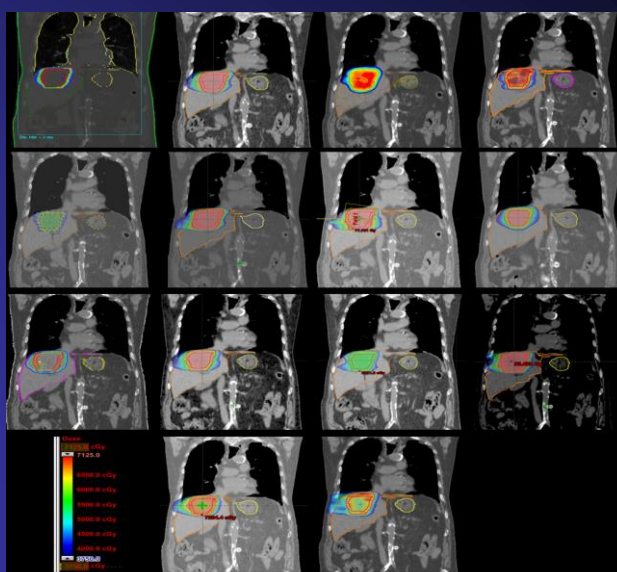
Prescrizione di dose:
Isodose minima al 67% cercando
di massimizzare al 95%

ORGAN	Dose-Volume Limits	Other Conditions
Healthy liver (defined as total liver volume minus cumulative GTV)	> 700 cc at < 15 Gy in 3 F	The volume of healthy liver > 1000 cc
Spinal cord	< 18 Gy in 3 F	
Kidneys (R+L)	V15 Gy < 35%	
Stomach, duodenum, small intestine	< 21 Gy in 3 F (also for minimum volumes)	Patients with GTV < 8 mm from the heart, stomach, duodenum and small intestine to be excluded
Ribs		30cc < 30Gy
Heart	<30 Gy in 3 F	

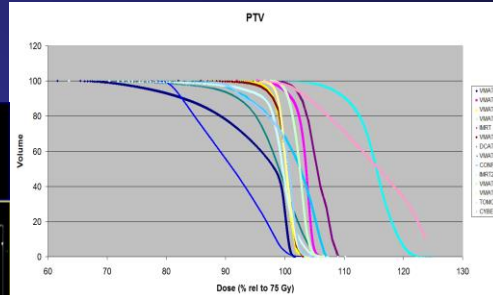
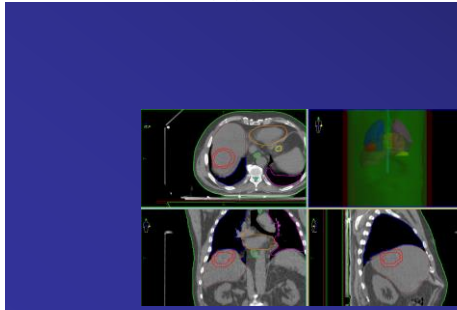
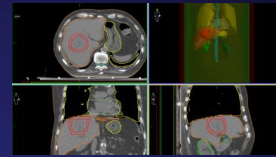
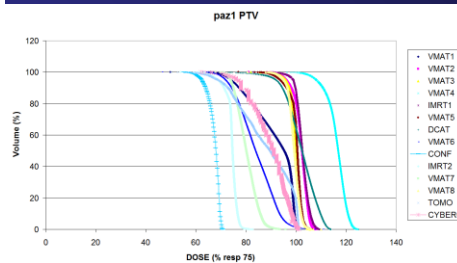
Progetto Fegato: partecipanti

	Experience in SBRT	TPS	Leaf dimensions/ collimator characteristic
VMAT1	high	Eclipse 11	2,5
VMAT2	high	Eclipse 11	2,5
VMAT3	high	Eclipse 8,9	5
VMAT4	high	Eclipse 10	5
VMAT5	high	Eclipse 8.6	5
VMAT6	high	Monaco 3.03	4
VMAT7	low	Monaco 3.20.02	10
VMAT8	no experience	Eclipse 10	5
IMRT1	low	Eclipse 8.9	5
IMRT2	low	Oncentra Masterplan ver.4.3	4
DCAT	high	Ergo	2,5
3dCONF	high	Precipe Plan 2.03	10
Tomo	high	TomoTherapy Hi-Art v. 4.2.1	6,25
Cyberg	high	Multiplan4.6	* 5mm 80 cm

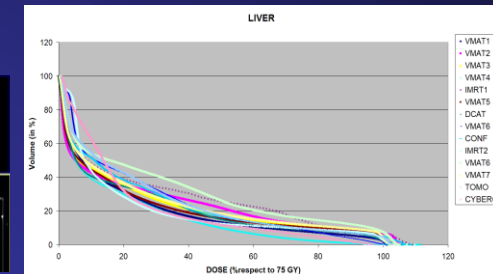
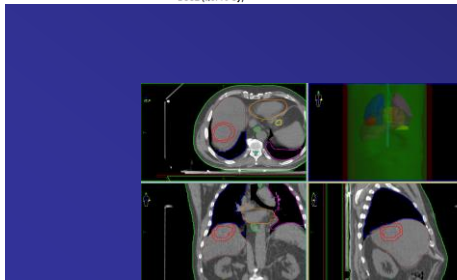
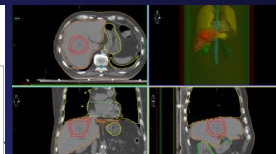
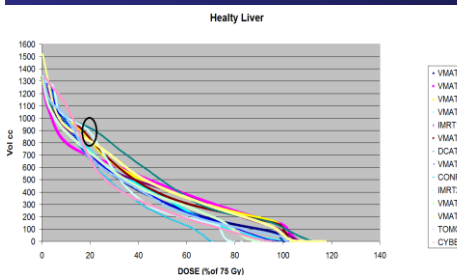
Progetto Fegato distribuzioni di dose



Progetto fegato: DVH PTV



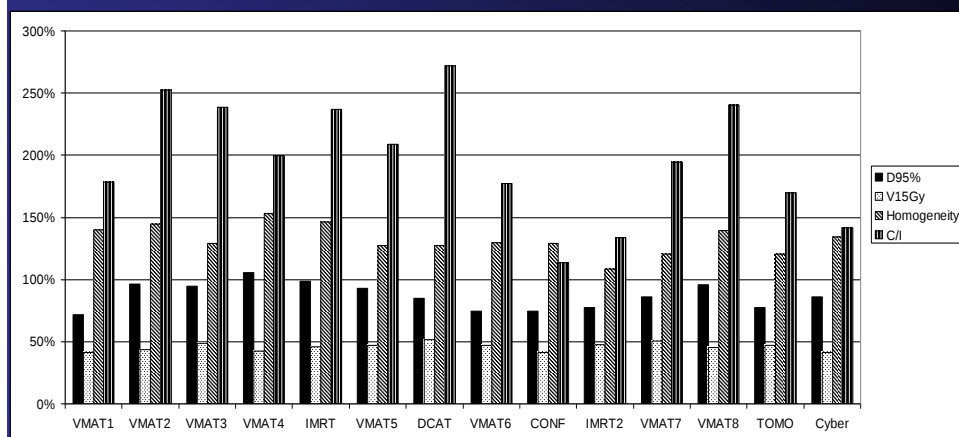
Progetto fegato: DVH fegato sano



Progetto fegato

Name	Experience in SABR	MU	BOT [min]	Constraint or objective violated
VMAT1	High	5935.4 ± 840.3	2.4 ± 0.2	none
VMAT2	High	7044.2 ± 365.7	2.94 ± 0.2	none
VMAT3	High	5208.6 ± 1059.6	3.4 ± 0.2	Liver constraint violated in pat 1
VMAT4	High	7325.6 ± 266.3	12.4 ± 0.9	none
VMAT5	High	5197.2 ± 862.2	8.6 ± 1.6	none
VMAT6	High	6966.8 ± 714.1	12.4 ± 1.1	none
VMAT7	Low	4453.2 ± 391.9	8.4 ± 1.0	Duodenum constraint of maximum dose violated in pat 2
VMAT8	No Experience	5396.0 ± 804.7	9.0 ± 1.3	none
IMRT1	Low	5372.2 ± 909.9	11.6 ± 5.9	none
IMRT2	Low	6734.8 ± 1084.9	13 ± 4.6	Liver constraint violated in pat 1
DCAT	High	3922.6 ± 804.7	22.0 ± 1.3	Liver constraint violated in pat 1
3D-CONF	High	4940.2 ± 1304.3	19.0 ± 4.2	Minum request of target's coverage not achieved in pat 1
Tomo	High	21676.4 ± 2234.8	25.1 ± 2.6	none
Cyber	high	15007.0 ± 1981.3	57 ± 2.3	none

Progetto fegato



Conclusioni

- Tutti i centri hanno dimostrato di poter raggiungere gli obiettivi di planning con le tecniche utilizzate
- Nella prostata e nel polmone non sono state riscontrate deviazioni significative dai vincoli di dose. Nel fegato, ne abbiamo riscontrato deviazioni importanti del vincolo di dose al fegato sano.
- Grande differenza nell'omogeneità di dose al target e nell'ottimizzazione residua del piano