ASSOCIAZIONE ITALIANA RADIOTERAPIA ONCOLOGICA

- CONGRESSO NAZIONALE -

30 SETTEMBRE, 1-2 OTTOBRE 2016, RIMINI

SKIN CANCER INTERVENTIONAL RADIOTHERAPY (BRACHYTHERAPY)

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Gemelli

Fondazione Policlinico Universitario A. Gemelli
Università Cattolica del Sacro Cuore

ART
Advanced Radiation Therapy

Interventional Radiotherapy
INTERACTS
Active Teaching School

ESTRO
Institutional member
2016

SKIN CANCER: EPIDEMIOLOGY

- **Non melanoma skin cancer**
  - 80% - Basal Cell Carcinoma (BCC)
  - 20% - Squamous Cell Carcinoma (SCC)
- **Melanoma**
- **Others rare histologies**

- Jemal A, Murray T, Ward E, Samuels A, Tiwari RC, Ghafoor A, Feuer EJ, Thun MJ. CA Cancer **J Clin. 2005** Jan-Feb;55(1):10-30.
- Perez and Brady's **Principles and Practice of Radiation Oncology - December 3, 2007** | ISBN-10: 078176369X Edition: Fifth

SKIN CANCER

- **Surgery or Radiotherapy**
- External Beam RT or Interventional RT
- Mould/Surface technique or Interstitial technique
- Conclusions

SKIN CANCER: MAIN THERAPIES

SURGERY

RADIOTHERAPY

External Beam Radiotherapy

Interventional Radiotherapy
(brachytherapy)

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- Perez and Brady's Principles and Practice of Radiation Oncology - December 3, 2007 | ISBN-10: 078176369X Edition: Fifth
- Radiotherapy in Practice – Brachytherapy, Peter J. Hoskin (Editor), Catherine Coyle (Editor) 3 Feb 2005 | ISBN-10: 0198529406

SKIN CANCER: MAIN THERAPIES

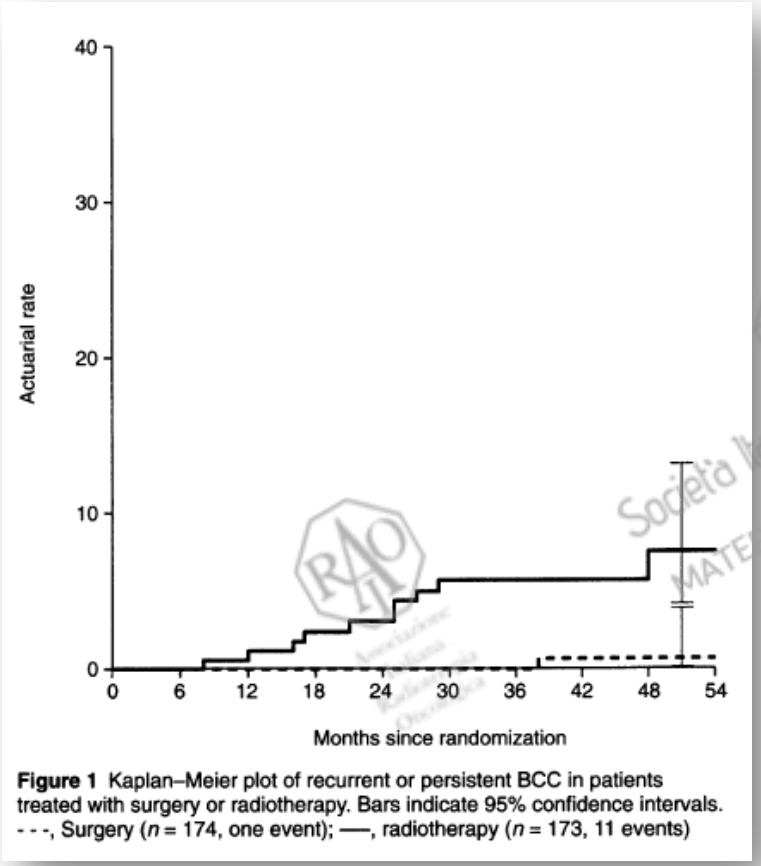


Figure 1 Kaplan–Meier plot of recurrent or persistent BCC in patients treated with surgery or radiotherapy. Bars indicate 95% confidence intervals. - - -, Surgery (n = 174, one event); —, radiotherapy (n = 173, 11 events)

Basal cell carcinoma of the face: surgery or radiotherapy? Results of a randomized study

M-F Avril[1], A Auperin[2], A Margulis[3], A Gerbaulet[4], P Duvillard[5], E Benhamou[2], J-C Guillaume[6], R Chalon[1], J-Y Petit[7], H Sancho-Garnier[8], M Prade[5], J Bouzy[2] and D Chassagne[4]

347 patients

The 4-year actuarial failure rate was

0.7% (0.1-3.9%) in the surgery group
7.5% (4.2-13.1%) in the RT group

(P = 0.003)

Gemelli ART Advanced Radiation Therapy

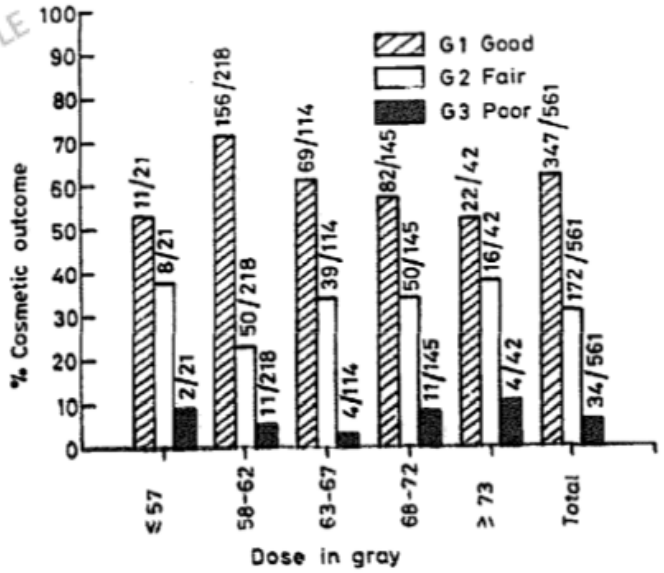
- Avril MF1, Auperin A, Margulis A, Gerbaulet A, Duvillard P, Benhamou E, Guillaume JC, Chalon R, Petit JY, Sancho-Garnier H, Prade M, Bouzy J, Chassagne D. Basal cell carcinoma of the face: surgery or radiotherapy? Results of a randomized study. Br J Cancer. 1997

SKIN CANCER: MAIN THERAPIES

Radiation therapy of carcinomas of the skin of nose and nasal vestibule: A report of 1676 cases by the Groupe Europeen de Curiethérapie

Local failure rates according to tumor diameter and histologic type.

	BCC		SCC	Total
0–1.9 cm	38/1039 (4%)	N.S.	5/130 (4%)	43/1169 (4%)
2–3.9 cm	32/273 (12%)	N.S.	15/104 (14%)	47/377 (12%)
4 cm or more	3/38 (8%)	$p < 0.02$	10/31 (32%)	13/69 (19%)
Unknown	4/47		0/14	4/61
Total	77/1397 (5.5%)		30/279 (11%)	107/1676 (6%)



Gemelli ART Advanced Radiation Therapy

- Mazeron JJ1, Chassagne D, Crook J, Bachelot F, Brochet F, Brune D, Brunin F, Bunescu U, Daly N, Danczak S, et al. Radiation therapy of carcinomas of the skin of nose and nasal vestibule: a report of 1676 cases by the Groupe Europeen de Curiethérapie. Radiother Oncol. 1988

SKIN CANCER: MAIN THERAPIES

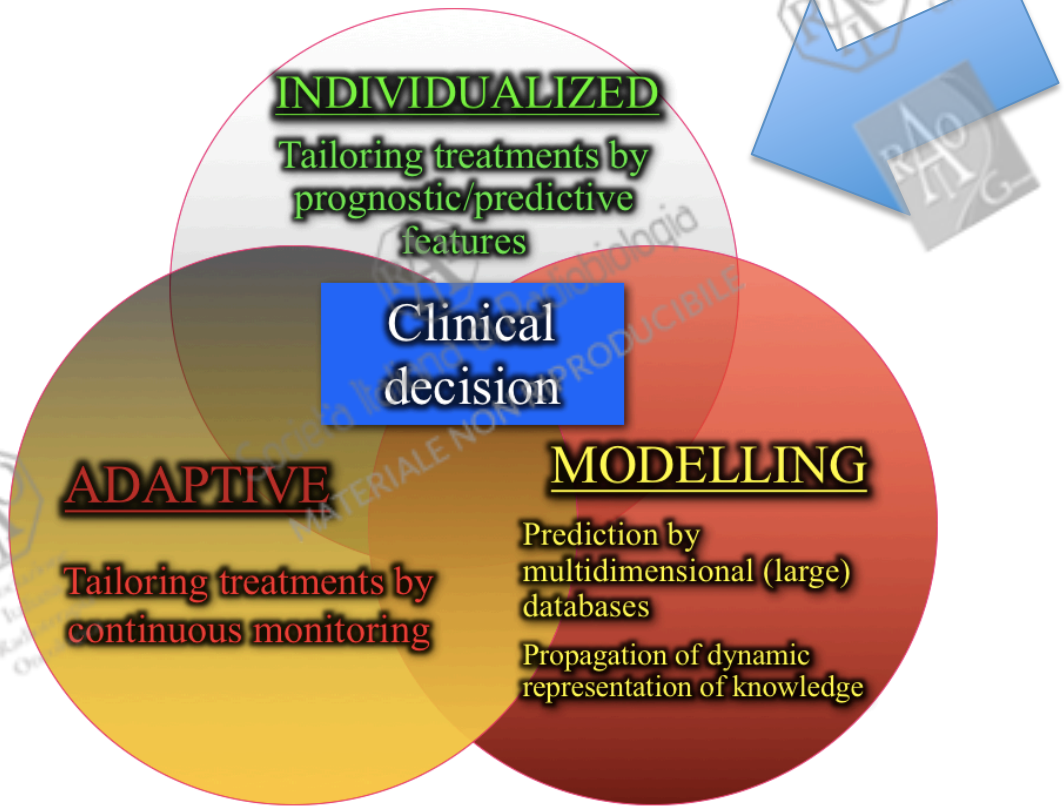
TABLE VI.
Local Tumor Control With Radiotherapy According to Size, Cell Type, and Presentation.[25]

Size	Basal Cell, Previously Untreated (%)	Basal Cell, Recurrent (%)	Squamous Cell, Previously Untreated (%)	Squamous Cell, Recurrent (%)
≤1 cm	64/66 (97)	22/23 (96)	11/11 (100)	10/12 (83)
1.1–3 cm	71/75 (95)	27/36 (75)	19/21 (90)	7/13 (54)
3.1–5 cm	11/13 (85)	7/9 (78)	7/8 (88)	6/9 (67)
>5 cm	12/13 (92)	1/2 (50)	3/5 (60)	6/11 (55)
Size not specified	4/4 (100)	1/1 (100)	0/1 (0)	4/6 (67)

From Mallinckrodt Institute of Radiology, St. Louis, Missouri.

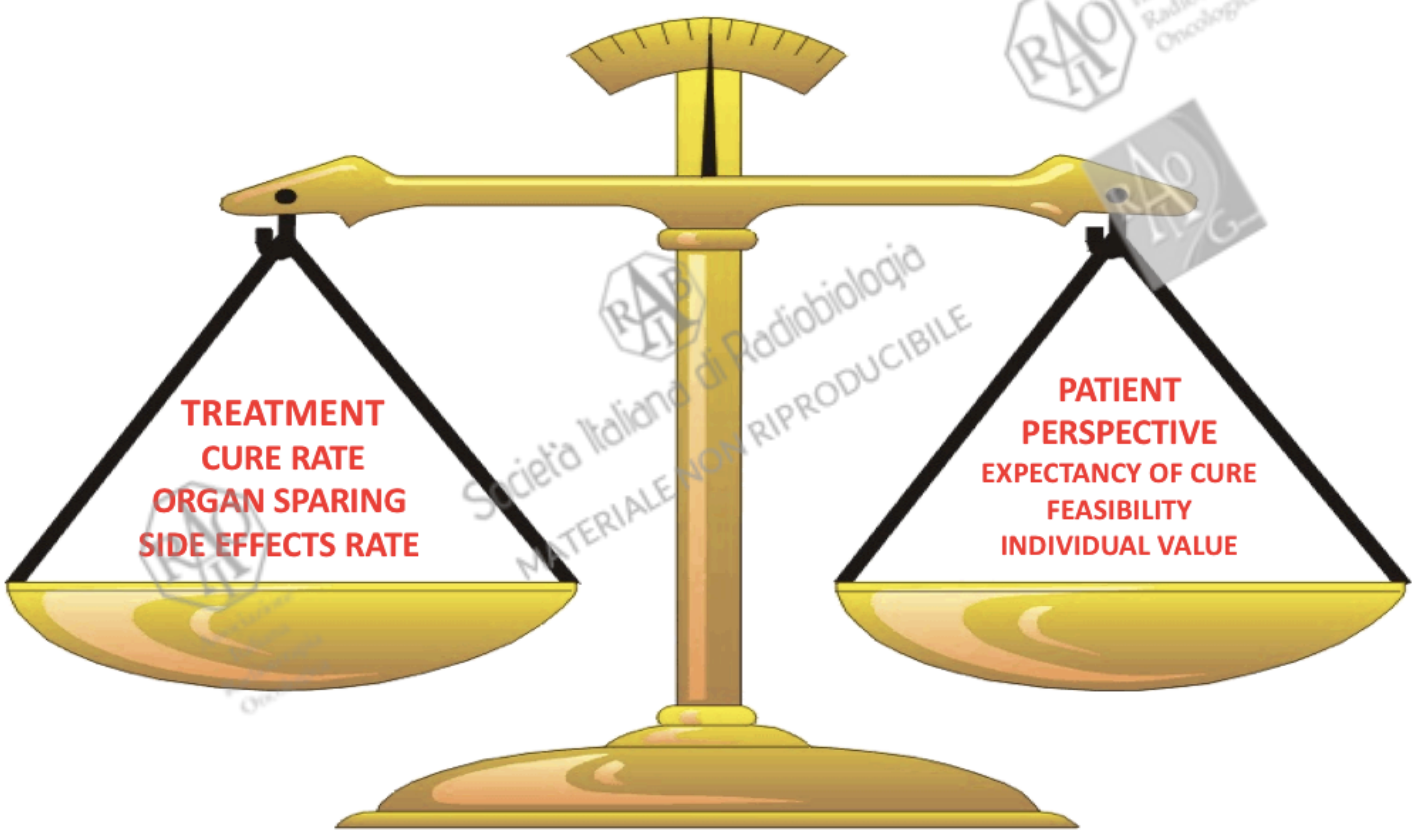
- Mendenhall WM, Amdur RJ, Hinerman RW, Cognetta AB, Mendenhall NP.Radiotherapy for cutaneous squamous and basal cell carcinomas of the head and neck. Laryngoscope. 2009

CHOICE OF THE BEST THERAPY



- **Courtesy of Prof. V. Valentini**

CHOICE OF THE BEST THERAPY



CHOICE OF THE BEST THERAPY

National Comprehensive Cancer Network®

PRINCIPLES OF TREATMENT FOR SQUAMOUS CELL SKIN CANCER

- The goals of primary treatment of squamous cell skin cancer are the cure of the tumor and the maximal preservation of function and cosmesis. All treatment decisions should be customized to account for the particular factors present in the individual case and for the patient's preference.

- Surgical approaches often offer the most effective and efficient means for accomplishing cure, but considerations of function, cosmesis, and patient preference may lead to choosing radiation therapy as primary treatment in order to achieve optimal overall results.

- NCCN, 2016

SKIN CANCER: RADIOTHERAPY

Box 1
Indications for radiation therapy

Primary radiation therapy

- Large tumors where clear surgical margins may be difficult to obtain
- Tumors located at certain anatomic sites where surgery could cause cosmetic or functional impairment (such as the eyelid, nose, ear, or lip)
- Tumors located along embryonic fusion planes
- Elderly, frail, or medically inoperable patients

Adjuvant postoperative radiation therapy

- Close, indeterminate, or positive margins after surgery
- Perineural invasion
- Multiple positive lymph nodes or nodal extracapsular extension

Palliative radiation therapy

- Symptomatic distant metastasis to soft tissue, bone, or lung
- Symptomatic (pain, bleeding, and/or mass effects) advanced incurable primary site disease

→ **Large Tumors**

→ **Facial triangle (nose, eyelid, ear, lip,eyes)**

→ **Elderly and frail patients**

→ **R+ or perineural invasion**

→ **N+**

→ **Palliative**

Gemelli ART Advanced Radiation Therapy

- Wang Y, Wells W, Waldron J. Indications and outcomes of radiation therapy for skin cancer of the head and neck. **Clin Plast Surg. 2009**

SKIN CANCER

- Surgery or Radiotherapy
- **External Beam RT or Interventional RT**
- **Mould/Surface technique or Interstitial technique**
- **Conclusions**

SKIN CANCER: RADIOTHERAPY

EXTERNAL BEAM RADIOTHERAPY

INTERVENTIONAL RADIOTHERAPY

Size – Location - Infiltration depth - Team expertise

Gemelli ART Advanced Radiation Therapy

- Treating recurrent cases of squamous cell carcinoma with radiotherapy. Wong J, Breen D, Balogh J, Czarnota GJ, Kamra J, Barnes EA. **Curr Oncol. 2008** Oct;15(5):229-33.
- Handbook of Evidence-Based Radiation Oncology. Eric K. Hansen, Mack, III, M.D. Roach

SKIN CANCER: BRACHITERAPIA

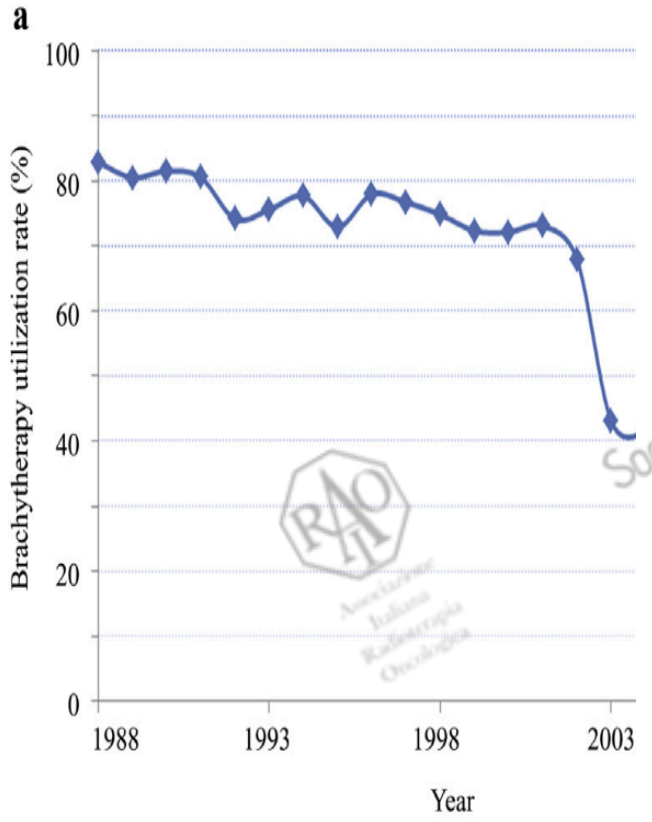
La Radiochirurgia
La Chirurgia
dell'Ernia e dell'Addome

Rivista Critica Internazionale Bimestrale

La guarigione degli epiteliomi cutanei trattati col Radium

- **Rivista critica internazionale, Napoli 1915**

BRACHYTHERAPY UTILISATION



RX EXPOSURE OF OPERATORS

DOSIMETRIC DIFFICULTIES

PREPARATION OF THE RADIOACTIVE MATERIAL FOR EACH PATIENT

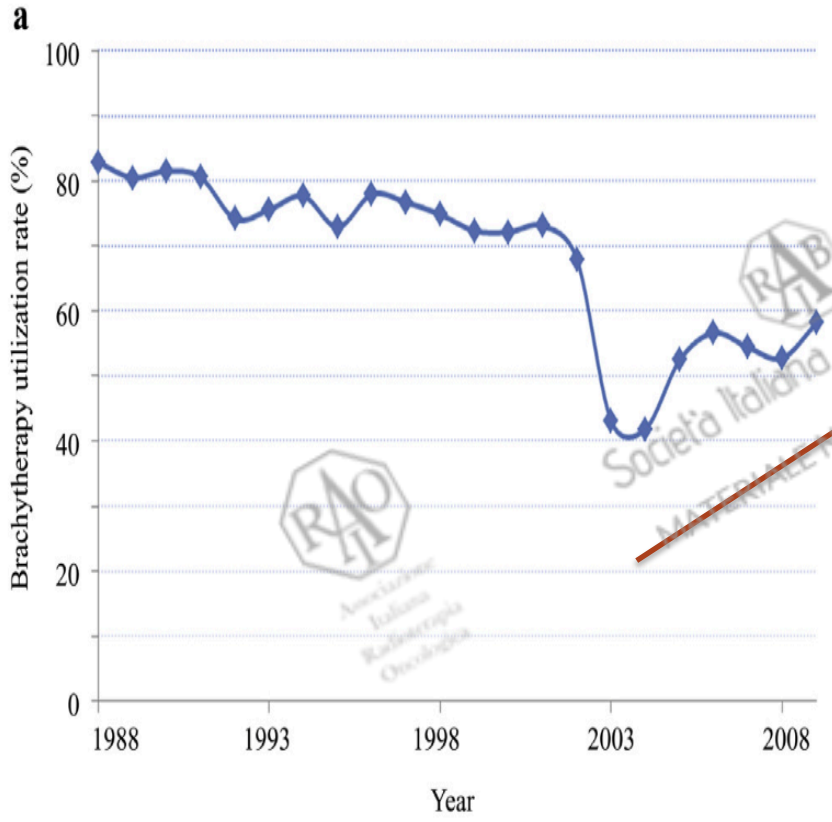
IMPLANT SYSTEMS

NO CT/MRI COMPATIBLE APPLICATORS

Gemelli ART Advanced Radiation Therapy

- Han K et al. **Int J Radiation Oncol Biol Phys**, Vol. 87, No. 1, pp. 111e119, **2013**

BRACHYTHERAPY UTILISATION

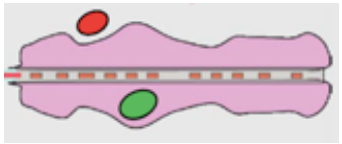


NEW ERA

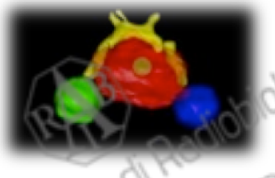
- Han K et al. **Int J Radiation Oncol Biol Phys**, Vol. 87, No. 1, pp. 111e119, **2013**

From BRACHYTHERAPY ERA to INTERVENTIONAL RADIOTHERAPY ERA

IMBT
Intensity Modulated BrachyTherapy
(individualised dose painting)



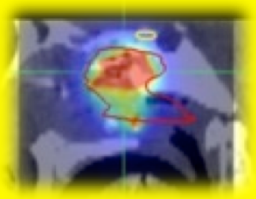
IGBT
Image Guided BrachyTherapy



MBT
Multidisciplinary Brachytherapy

Image Adapted Interventional Radiotherapy

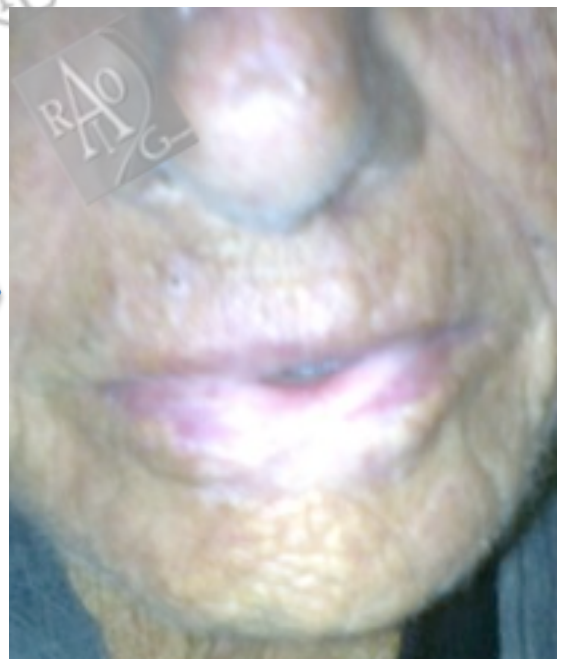
Image AIR



Gemelli ART Advanced Radiation Therapy

- Kovács G. - Modern head and neck brachytherapy: from radium towards intensity modulated interventional brachytherapy. **J Contemp Brachytherapy. 2015**.
- Tagliaferri L. - Perioperative HDR-IMBT for re-irradiation in head and neck recurrences. **Interdisciplinary Teaching Course On Head And Neck Brachytherapy Rome, 20 - 22 May 2016**

Linear sources (LDR) vs Image AIR



- Catholic University of Rome experience

Gemelli ART Advanced Radiation Therapy

Linear sources (LDR) vs Image AIR

Author	*n*	Dose (Gy)	LDR	HDR	PDR	5 years local control (%)	5 years OS (%)	Toxicity
Beauvois *et al.* [21]	237	65-68	^{192}Ir	–	–	95	74	9.5% necrosis
Gerbaulet *et al.* [22]	231	76	^{192}Ir	–	–	95	n.d.	13.0% necrosis
Tombolini *et al.* [24]	57	62	–	HDR	–	90 (10 yrs)	n.d	n.d.
Guinot *et al.* [26]	104	9 × 5.0 bid	–	HDR IMBT	–	95.2	64.4	0%
Lock *et al.* [173]	51	55	^{198}Au	–	–	97.8	87.9	Good cosmesis 48/51
Serkies *et al.* [25]	32	60-70	–	–	PDR	98		2/32
Johannson *et al.* [20]	43	60	–	–	PDR	94.5 (10 yrs)	58.9 39.1 (10 yrs)	2% soft tissue necrosis 2% bone necrosis

- Kovács G. - Modern head and neck brachytherapy: from radium towards intensity modulated interventional brachytherapy. **J Contemp Brachytherapy. 2015.**

Linear sources (LDL) vs Image AIR

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LDR

I-AIR

I-AIR

- Kovács G. - Modern head and neck brachytherapy: from radium towards intensity modulated interventional brachytherapy. **J Contemp Brachytherapy. 2015.**

SKIN CANCER: RADIOTHERAPY

External Beam Radiotherapy vs Interventional Radiotherapy

Table 1. Dose distribution of 6 MeV electrons (EBRT) (with 0.5 cm bolus) and HDR-BT (Freiburg applicator, distance between applicator and skin surface – 5 mm) [9]

Depth [cm]	Electrons 6 MeV, % dose	HDR-BT (normalized on 0.2 cm depth), % dose
0.0	88	105–110
0.5	98	85
1.0	98	65
1.5	78	55
2.0	36	30

RAPID DOSE FALL OFF

- Skowronek J, Brachytherapy in the treatment of skin cancer: an overview. **Postepy Dermatol Alergol. 2015**

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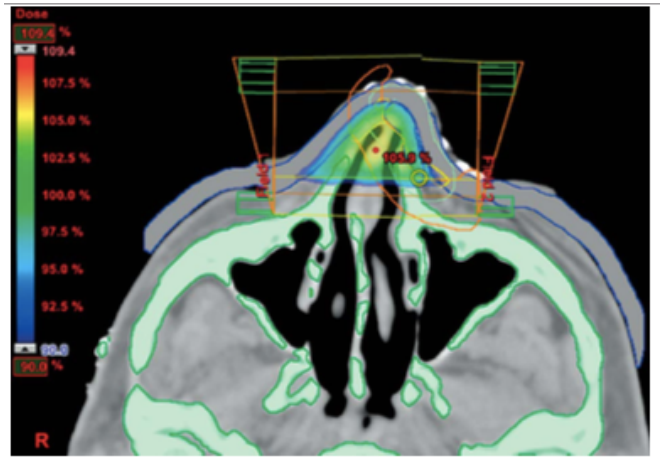
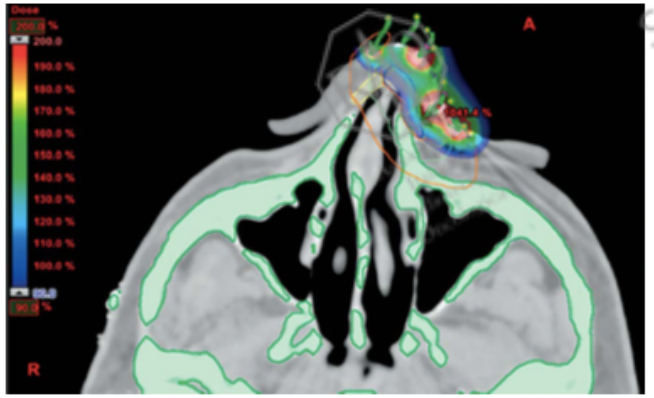
SKIN CANCER: RADIOTHERAPY

External Beam Radiotherapy vs Interventional Radiotherapy





Better protection of subcutaneous tissues

	BT plans	EBRT plans	*p*
V_{10}	183.4cc	65.7cc	0.005
V_{20}	69.4cc	49.6cc	0.017
V_{30}	37.2cc	42.1cc	0.959
V_{50}	16.7cc	31.3cc	0.074
V_{70}	9.1cc	23.6cc	0.005
V_{90}	5.5cc	16.0cc	0.005

Better tumor radiation coverage

	BT plans	EBRT plans	*p*
D_{90}	99.4%	93.9%	0.139
V_{PTV90}	96.4%	95.8%	0.721
V_{PTV100}	89.4%	71.2%	0.013

Gemelli ART Advanced Radiation Therapy

- Kuncman Ł, Kozłowski S, Pietraszek A, Pietrzykowska-Kuncman M, Danielska J, Sobotkowski J, Łuniewska-Bury J, Fijuth J. Highly conformal CT based surface mould brachytherapy for non-melanoma skin cancers of earlobe and nose. **J Contemp Brachytherapy. 2016**

INTERVENTIONAL RADIOTHERAPY

FIRST THERAPEUTIC CHOICE

Tumor localized

- **in anatomical curves**
- **near critical organs**

} **ESPECIALLY FACE/FINGERS**

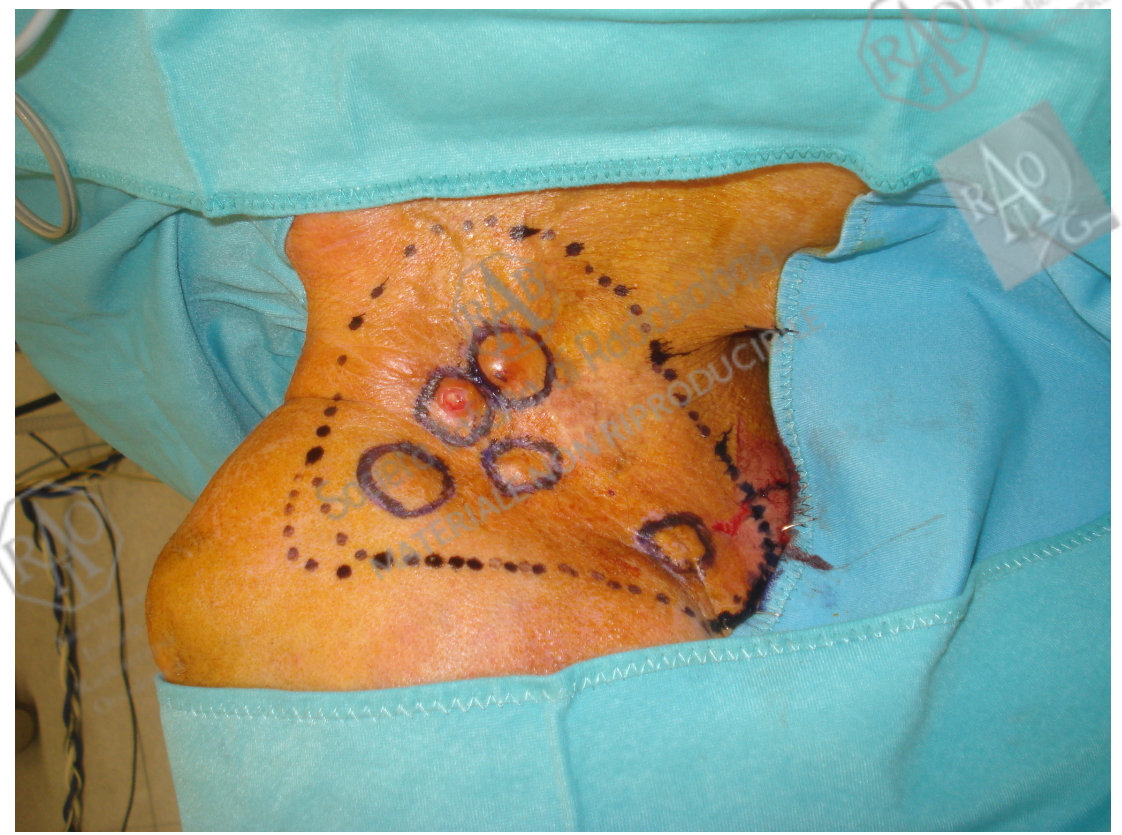
- **in previously treated area**

- Skowronek J, Brachytherapy in the treatment of skin cancer: an overview. **Postepy Dermatol Alergol. 2015**

Gemelli ART Advanced Radiation Therapy

Image AIR

Image Adapted Interventional Radiotherapy

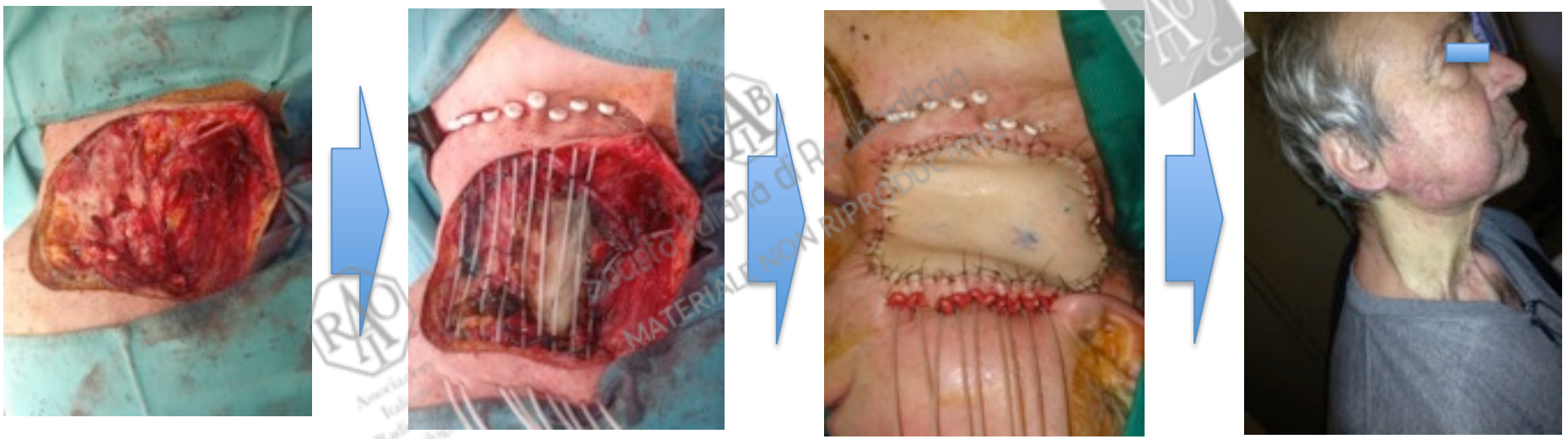


- Catholic University of Rome experience

Gemelli ART Advanced Radiation Therapy

Image AIR

Image Adapted Interventional Radiotherapy



- Catholic University of Rome experience

Gemelli ART Advanced Radiation Therapy

Image AIR

Image Adapted Interventional Radiotherapy

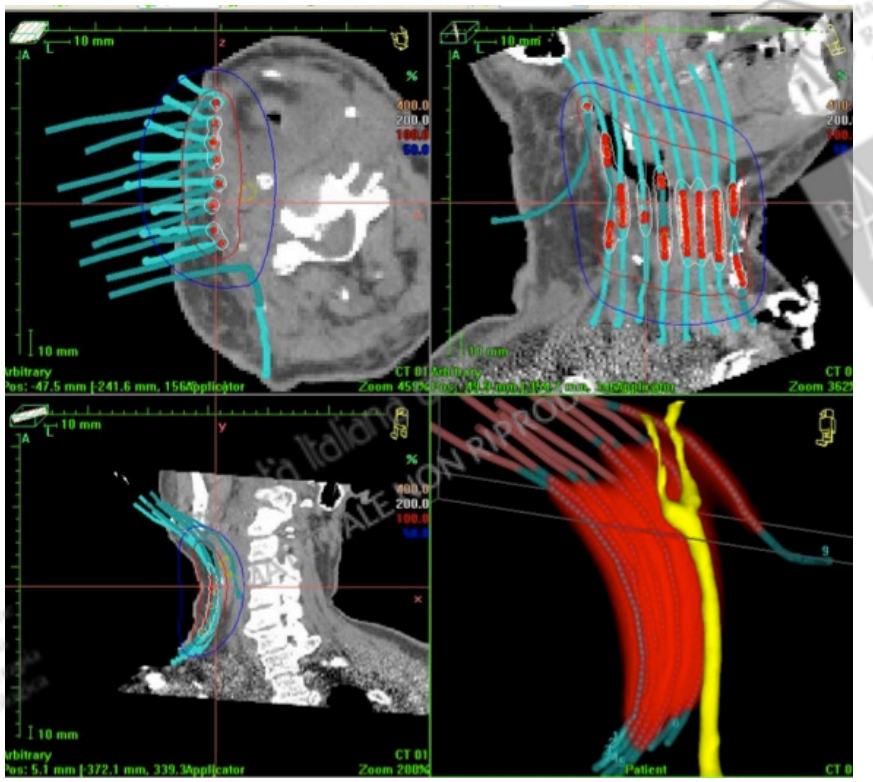


Image based dose painting

- Catholic University of Rome experience

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SKIN CANCER

- Surgery or Radiotherapy
- External Beam RT or Interventional RT
- **Mould/Surface technique or Interstitial technique**
- **Conclusions**

CHOICE OF TECHNIQUE AND PRESCRIPTION POINT

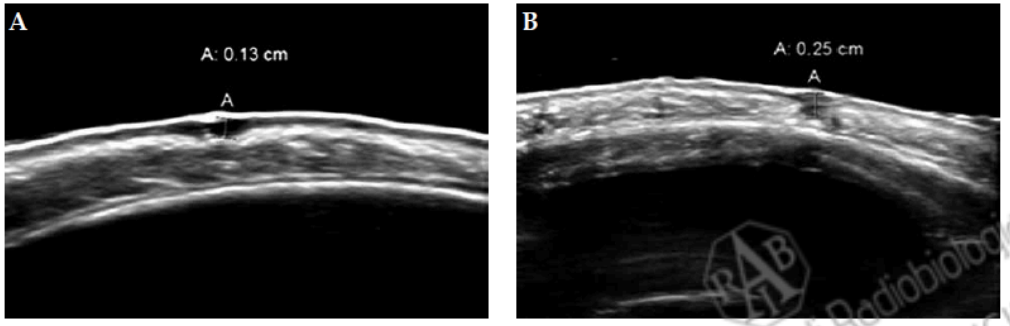

Fig. 3. High frequency ultrasonography examples of depth measurement. A) Superficial basal cell carcinoma. B) Nodular basal cell carcinoma

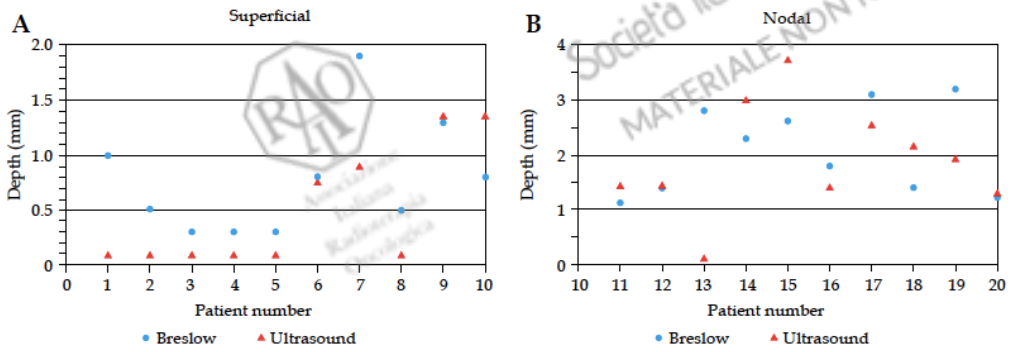

Fig. 4. A) Histopathology (Breslow rate) vs. high frequency ultrasonography (HFUS) depth determination for the 10 patients evaluated with superficial basal cell carcinoma (BCC). B) The same but with nodular BCC

TUMOR DIMENSION EVALUATION

Staging
(technique choice)

Monitoring lesion

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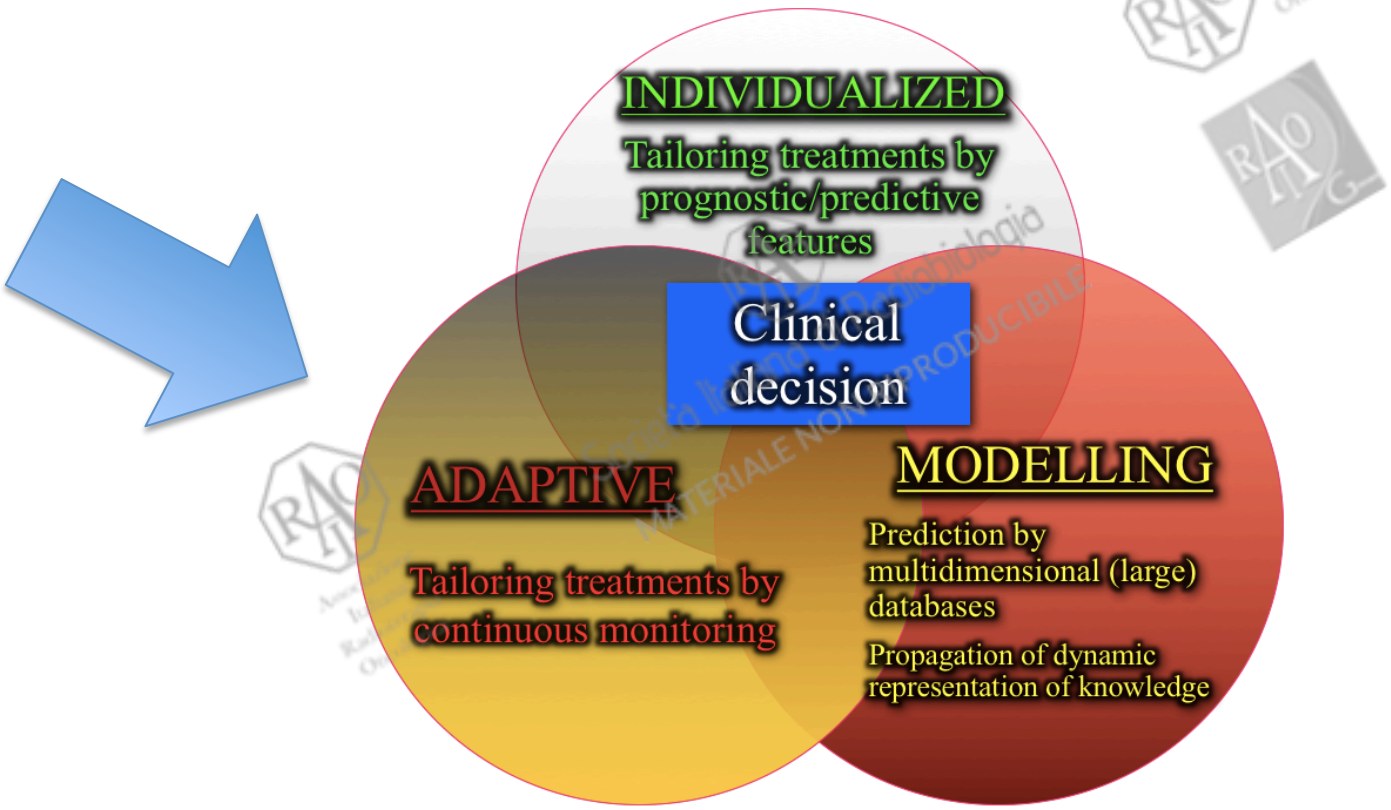
- Ballester-Sánchez R, Pons-Llanas O, Llavador-Ros M, Botella-Estrada R, Ballester-Cuñat A, Tormo-Micó A, Javier Celadá-Álvarez F, Rodríguez-Villalba S, Santos-Ortega M, Ballester-Pallarés F, Perez-Calatayud J. Depth determination of skin cancers treated with superficial brachytherapy: ultrasound vs. histopathology. **J Contemp Brachytherapy. 2015**

CHOICE OF THE BEST THERAPY



- **Courtesy of Prof. V. Valentini**

MOULD/SURFACE TECHNIQUE
Valencia/Leipzing Applicator or mould








Lesion <5mm

Gemelli ART Advanced Radiation Therapy

- Nag S, Caro ER, Demanes JD, et al. The American Brachytherapy Society recommendations for high dose rate brachytherapy for head and neck carcinoma. **Int J Oncol Biol Phys 2001;**
- Tormo A, Celada F, Rodriguez S, Botella R, Ballesta A, Kasper M, Ouhib Z, Santos M, Perez-Calatayud J.Non-melanoma skin cancer treated with HDR Valencia applicator: clinical outcomes. **J Contemp Brachytherapy. 2014**

MOULD/SURFACE TECHNIQUE
Valencia/Leipzing Applicator or mould

Electrician – refuses amputation

- Catholic University of Rome experience 2015

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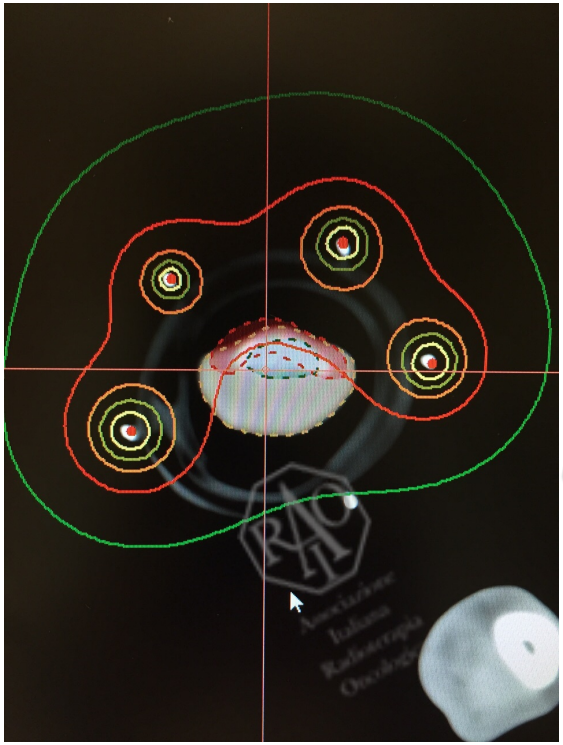
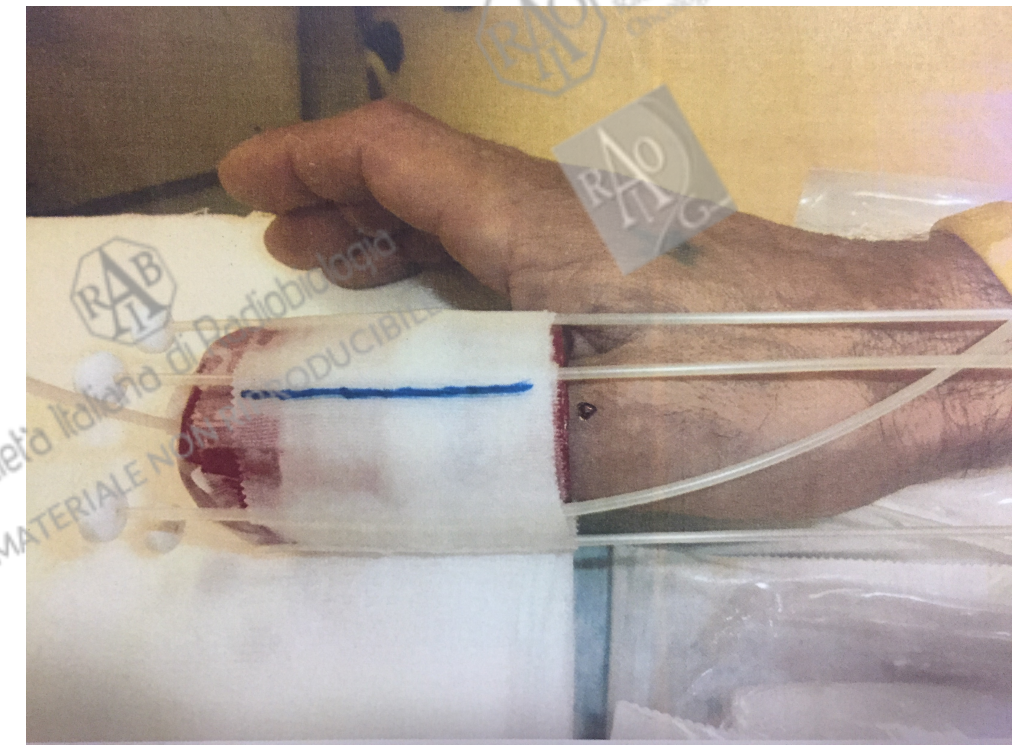
MOULD/SURFACE TECHNIQUE
Valencia/Leipzing Applicator or mould





- Catholic University of Rome experience 2015

Gemelli ART Advanced Radiation Therapy

MOULD/SURFACE TECHNIQUE
Valencia/Leipzing Applicator or mould

- Catholic University of Rome experience 2015

ELECTRONIC BRACHYTHERAPY

Table 1 A comparison of several physical characteristics of the currently available eBT devices

Device	Maximum energy	Half-value (mm Al)	Dose rate	Beam current	Source-surface distance	Source diameter
Xoft® Axxent®	50 kV	0.5 (bare source) 1.6 (endocavitary applicator)	0.6 Gy/min at 3 cm depth	300 μA	25 mm	2.25 mm point source
Zeiss® INTRABEAM®	50 kV	0.1 (bare source) 0.8–1.3 (spherical applicators)	2 Gy/min at 1 cm depth	5–40 μA	9.6–21.6 mm	3.2 mm point source
Elekta® Esteya®	69.5 kV	1.83 (surface applicator)	2.7 Gy/min at 3 mm depth	0.5–1.6 mA	60 mm	Collimated window type source

Gemelli ART Advanced Radiation Therapy

- Kasper ME, Chaudhary AA. Novel treatment options for nonmelanoma skin cancer: focus on electronic brachytherapy. **Med Devices (Auckl). 2015**
- Ballester-Sánchez R, Pons-Llanas O, Candela-Juan C, Celada-Álvarez FJ, Barker CA, Tormo-Micó A, Pérez-Calatayud J, Botella-Estrada R. Electronic brachytherapy for superficial and nodular basal cell carcinoma: a report of two prospective pilot trials using different doses. **J Contemp Brachytherapy. 2016**

ELECTRONIC BRACHYTHERAPY

	Author	Number of NMSC/BCC	Applicator	No. of fractions	Total dose (Gy)	Dose/ fraction (Gy)	Frequency	Prescription	BED keV	Median followup (months)	Local control (%)
SURFACE APPLICATORS	Köhler-Brock *et al.* [40]	520/282	Leipzig	–	30-40	5-10	1-2 times a week	6-8 mm	–	6-125	91
	Gauden *et al.* [37]	92/	Leipzig	12	36	3	Daily	Leipzig appropiate depth	46.8	37	97
	Ghaly *et al.* [36]	67/	Leipzig	8	40	5	Twice a week	Leipzig appropiate depth	60.0	18	95.5
	Tormo *et al.* [10]	48/45	Valencia	6	42	7	Twice a week	4 mm	70.0	–	98
	Delishaj *et al.* [33]	53/42	Valencia	8-10	40-50	5	2-3 times a week	–	60.0-75.0	12	96.2
ELECTRONIC BRACHYTHERAPY	Bhatnagar [4,35]	297/167	EBT (Xoft®)	8	40	5	Twice a week	Depth base don CT or 3 mm	50	16.5	99
	Dogget *et al.* [5]	565/238	EBT (Xoft®)	8	40	5	Twice a week	–	50.0	12.5	99.8
	Strimling *et al.* [6]	508/275	EBT (Xoft®)	8	40	5	Twice a week	0-5 mm	–	3.4	99.4
	Paravati *et al.* [7]	154/149	EBT (Xoft®)	8	40	5	Twice a week	2-3 mm	–	16	98.7
	Ballester *et al.* [27]	40/40	EBT (Esteya®)	6	36.6-42	6.1-7	Twice a week	Esteya® applicators	69.5	12	90-95

SURFACE APPLICATORS
ELECTRONIC BRACHYTHERAPY

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- Ballester-Sánchez R, Pons-Llanas O, Candela-Juan C, Celada-Álvarez FJ, Barker CA, Tormo-Micó A, Pérez-Calatayud J, Botella-Estrada R. Electronic brachytherapy for superficial and nodular basal cell carcinoma: a report of two prospective pilot trials using different doses. **J Contemp Brachytherapy. 2016**

INTERSTITIAL TECHNIQUE

NON MELANOMA SKIN CANCER OF EYELID

Authors (reference)	Follow up (months)	LC	Acute toxicity	Late toxicity	Functional and cosmetic outcome
Daly *et al.* [13]	24-72	96.4% (crude)	Edematous reaction: 29.6% Conjunctival erythema: 12%	Epilation: 100% Pigmentation: 14.5% Impairment of the eyelid fissure: 5.5% Stenosis of lacrimal duct: 9.5% Eversion of the lower lid: 4.4% Small ulcer of the cornea: 0.6%	NR
Conill *et al.* [14]	Mean: 43	91.6% (crude)	G1 Edematous reaction: 100% G1 Skin erythema: 100% G1 Conjunctival erythema: 100%	G1-2 Epilation: 100%	Good: 100%
Azad *et al.* [15]	Median: 39.5	5-year: 75.6%	Erythema and mild lid edema: 90% Conjunctival congestion and chemosis: 55%	Keratitis: 5% Epiphora: 5% Lid fibrosis: 15% Depigmentation: 10% Epilation: 70%	Good and acceptable: 100%
Krengli *et al.* [19]	Mean: 92	96.7% (crude)	G2-G3 Conjunctivitis: 80% G1 Keratitis: 21.7%	Stenosis of lacrimal duct: 6.7% G1 Epiphora: 5% Ectropion: 5% Unilateral cataract: 3.3%	Optimal: 68.3% Satisfactory: 23.3% Unsatisfactory: 8.3%
Laskar *et al.* [20]	Median: 35	100% (crude)	G1 Erythema: 75% G1 Epiphora: 25%	G1 Pigmentation: 14.2% G1 Ectropion: 14.2%	Excellent/very good: 100%*
Mareco *et al.* [21]	Median: 40	94.1% (crude)	G1 Radiodermatitis: 52% G2 Radiodermatitis: 12% G3 Radiodermatitis: 12% G1 Conjunctivitis: 42% Hematoma: 46%	G1-2 Keratoconjuctivitis secca: 46% G1-2 Conjuctivitis: 42% G1-2 Epilation: 65% G1-2 Skin atrofy: 36% G1-2 Eyelid malocclusion: 46% G1-2 Impairment of the eye aperture: 12% G1-2 Edema: 18% G1-2 Fibrosis: 18% G1-2 Pruritus: 46% G1-2 Burn pain: 36% G1-2 Pigmentation changes: 47% G1-2 Hyperlacrimation: 18% G1-2 Entropion: 23%	Excellent: 29% Good: 41% Satisfactory: 12% Not available: 18%

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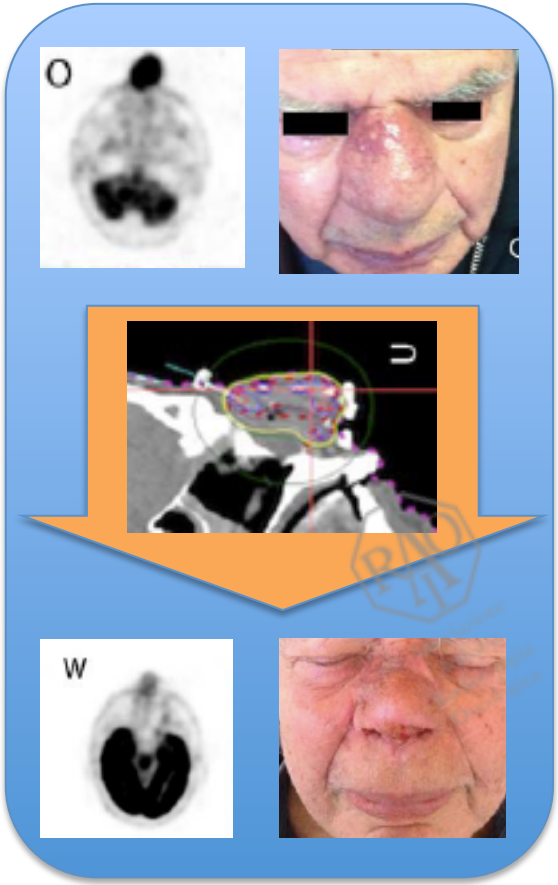
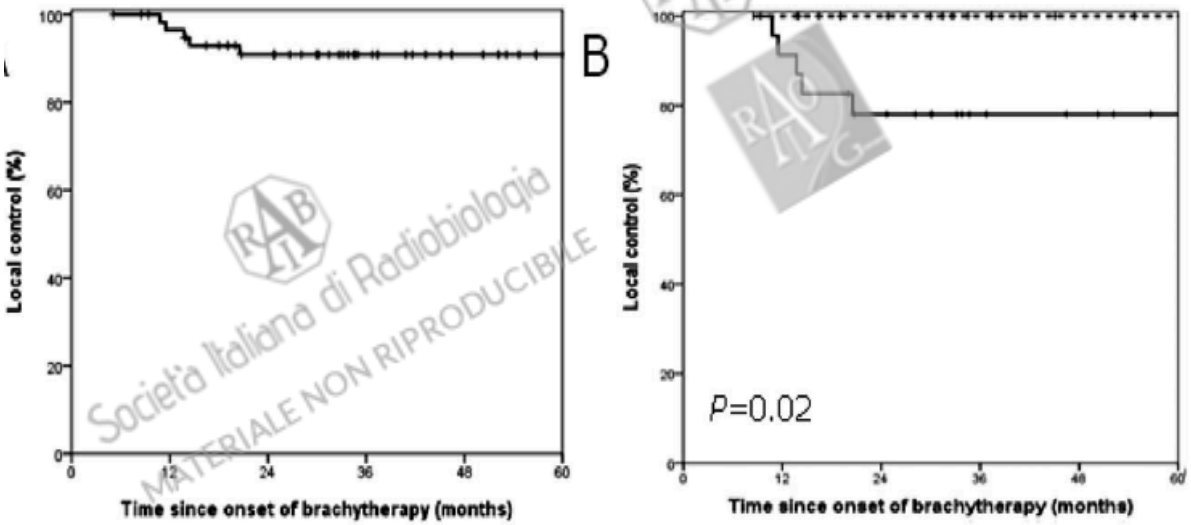
- Frakulli R, Galuppi A, Cammelli S, Macchia G, Cima S, Gambacorta MA, Cafaro I, Tagliaferri L, Perrucci E, Buwenge M, Frezza G, Valentini V, Morganti AG. Brachytherapy in non melanoma skin cancer of eyelid: a systematic review. **J Contemp Brachytherapy. 2015**

INTERSTITIAL TECHNIQUE

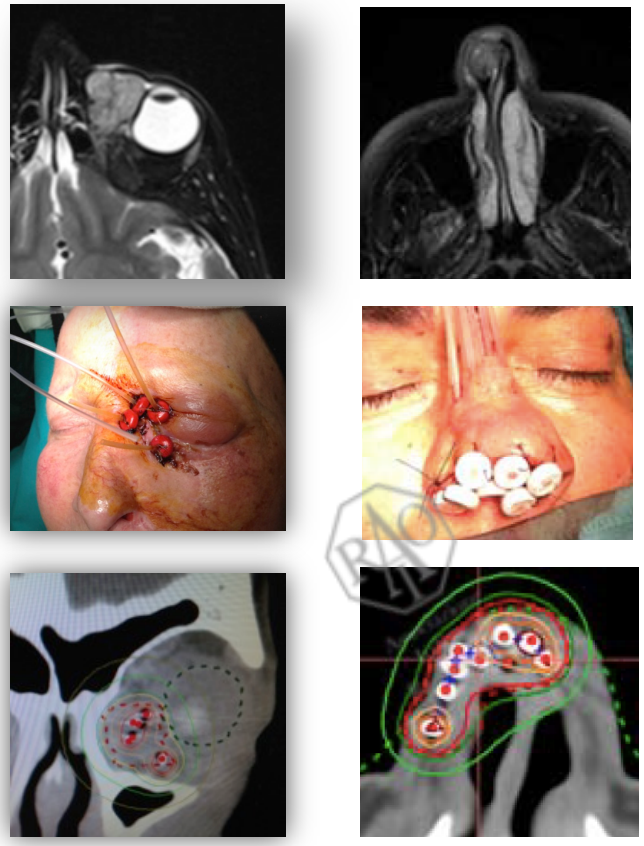


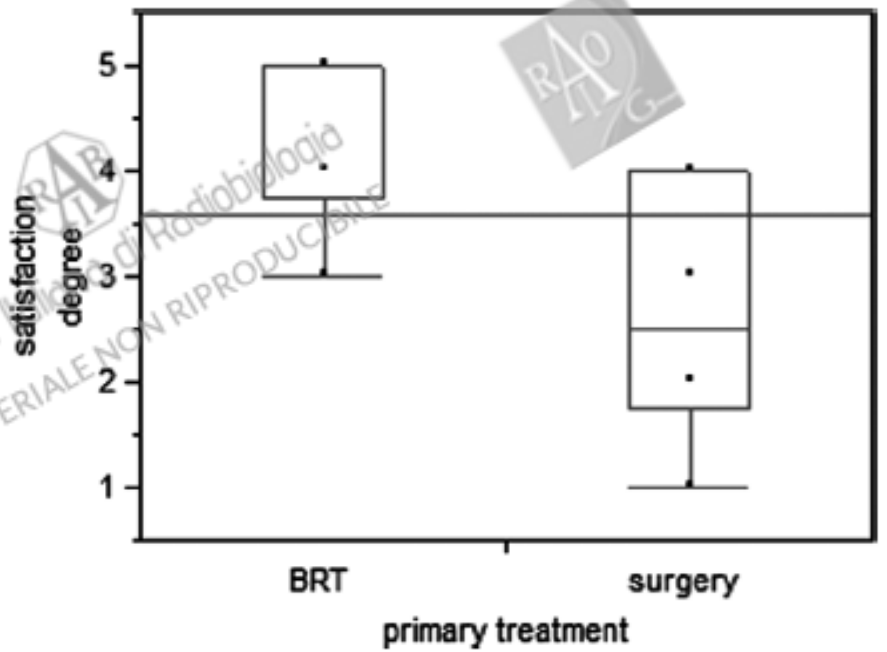


<1.5 cm; dotted line vs 1.5 cm; straight line

- Lipman D, Verhoef LC, Takes RP, Kaanders JH, Janssens GO. Outcome and toxicity profile after brachytherapy for squamous cell carcinoma of the nasal vestibule. **Head Neck. 2015**
- Bussu F, Tagliaferri L, Mattiucci G, Parrilla C, Dinapoli N, Miccichè F, Artuso A, Galli J, Almadori G, Valentini V, Paludetti G. Comparison of interstitial brachytherapy and surgery as primary treatments for nasal vestibule carcinomas. **Laryngoscope. 2016**

INTERSTITIAL TECHNIQUE





- Bussu F, Tagliaferri L, Mattiucci G, Parrilla C, Dinapoli N, Miccichè F, Artuso A, Galli J, Almadori G, Valentini V, Paludetti G. Comparison of interstitial brachytherapy and surgery as primary treatments for nasal vestibule carcinomas. **Laryngoscope. 2016**

SKIN CANCER

- Surgery or Radiotherapy
- External Beam RT or Interventional RT
- Mould/Surface technique or Interstitial technique
- **Conclusions**

CONCLUSIONS

The definitive therapeutic choice depends on the characteristics of the disease, its location and the possible cosmetic results

- **Surgery**, in general, if possible, is the first therapeutic choice (especially <60 Years)
- **Radiotherapy (EBRT or IR)** is indicated especialiy in inoperable tumors for medical reasons (elder and debilitated patients) and tumors of the face or in areas cosmetically or functionally sensitive
- **Interventional Radiotherapy** is the first therapeutic choice in tumors of the face (especially on the lips, nose, ears, eyelids) and in previously treated area
- **Technique** Lesion < 5mm: Mould/Surface technique – lesion >5mm: Interstitial technique

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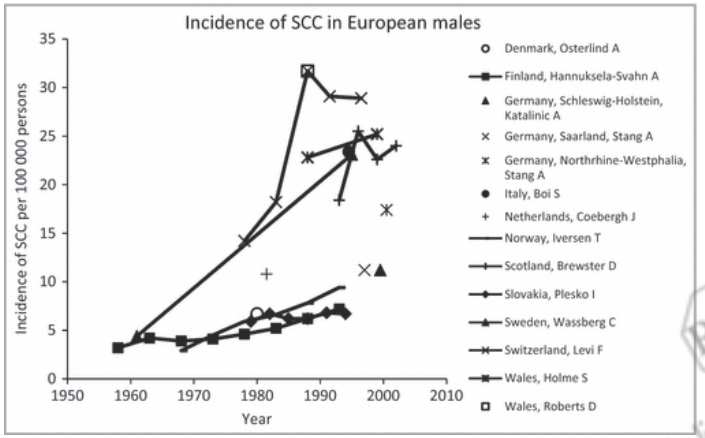
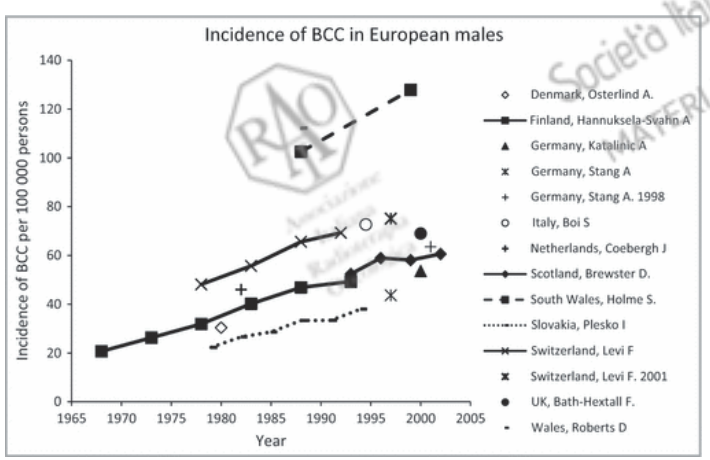
FUTURE CONSIDERATIONS: Incidence





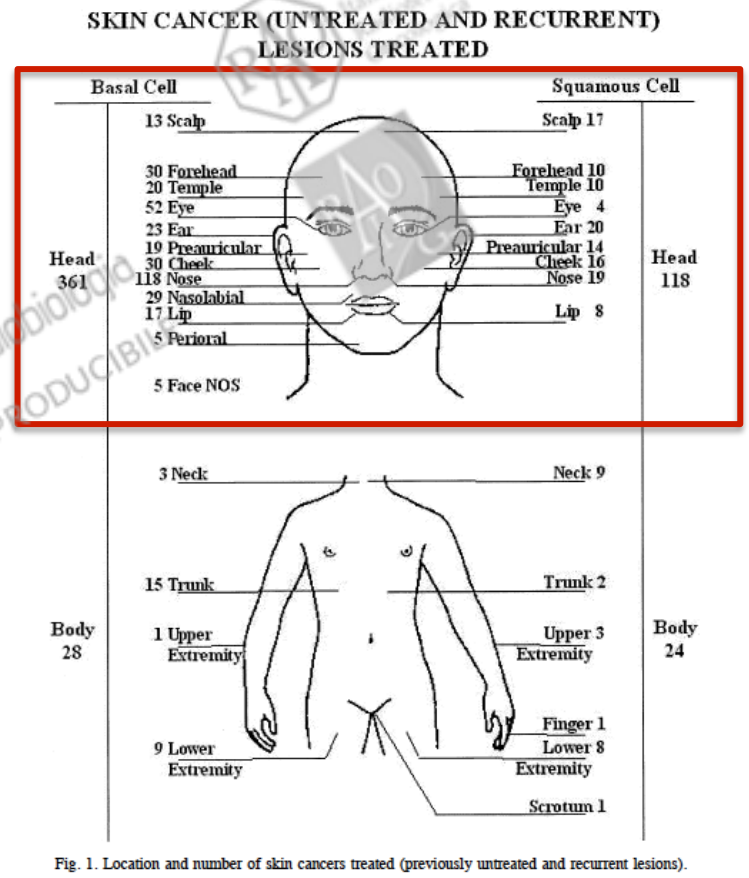


Fig. 1. Location and number of skin cancers treated (previously untreated and recurrent lesions).

- Locke J, Karimpour S, Young G, Lockett MA, Perez CA. Radiotherapy for epithelial skin cancer. **Int J Radiat Oncol Biol Phys. 2001**
- Lomas A, Leonardi-Bee J, Bath-Hextall F. A systematic review of worldwide incidence of nonmelanoma skin cancer. **Br J Dermatol. 2012**

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FUTURE CONSIDERATIONS: Costs

	All skin cancer (melanoma or nonmelanoma)			Nonmelanoma skin cancer			Melanoma skin cancer			All cancer sites (excluding skin cancer)		
	2002–2006, *n* (SE)	2007–2011, *n* (SE)	*p*-value[a]	2002–2006, *n* (SE)	2007–2011, *n* (SE)	*p*-value[a]	2002–2006, *n* (SE)	2007–2011, *n* (SE)	*p*-value[a]	2002–2006, *n* (SE)	2007–2011, *n* (SE)	*p*-value[a]
Persons with cancer treatment	3,419,507 (170,507)	4,914,910 (243,528)	<0.001	3,090,442 (154,887)	4,301,338 (224,361)	<0.001	372,536 (44,081)	700,647 (59,659)	<0.001	7,809,643 (236,563)	10,345,779 (311,917)	<0.001
	% (SE)	% (SE)		% (SE)	% (SE)		% (SE)	% (SE)		% (SE)	% (SE)	
PERCENT WITH CANCER TREATMENT												
Aged ≥18 years												
Male and female	1.55 (0.07)	2.12 (0.09)	<0.001	1.40 (0.06)	1.85 (0.09)	<0.001	0.17 (0.02)	0.30 (0.03)	<0.001	3.55 (0.08)	4.46 (0.10)	<0.001
Male	1.76 (0.10)	2.40 (0.12)	<0.001	1.58 (0.09)	2.12 (0.12)	<0.001	0.21 (0.03)	0.32 (0.04)	0.019	3.14 (0.12)	4.07 (0.15)	<0.001
Female	1.36 (0.08)	1.85 (0.11)	<0.001	1.24 (0.08)	1.60 (0.10)	0.003	0.13 (0.02)	0.28 (0.03)	<0.001	3.92 (0.11)	4.83 (0.13)	<0.001
Age 18–64 years												
Male and female	0.81 (0.05)	0.94 (0.06)	0.081	0.70 (0.04)	0.79 (0.05)	0.202	0.11 (0.02)	0.17 (0.02)	0.068	2.26 (0.06)	2.74 (0.08)	<0.001
Male	0.84 (0.07)	0.89 (0.08)	0.617	0.72 (0.05)	0.77 (0.07)	0.56	0.13 (0.03)	0.12 (0.02)	0.874	1.55 (0.08)	1.97 (0.10)	0.001
Female	0.78 (0.07)	0.99 (0.08)	0.042	0.68 (0.06)	0.80 (0.07)	0.194	0.10 (0.02)	0.21 (0.03)	0.006	2.96 (0.10)	3.48 (0.13)	0.001
Aged ≥65 years												
Male and female	5.23 (0.27)	7.66 (0.35)	<0.001	4.87 (0.26)	6.86 (0.32)	<0.001	0.44 (0.06)	0.94 (0.11)	<0.001	9.87 (0.31)	12.56 (0.37)	<0.001
Male	7.01 (0.47)	10.53 (0.53)	<0.001	6.46 (0.45)	9.34 (0.49)	<0.001	0.67 (0.11)	1.38 (0.20)	0.002	12.17 (0.53)	15.31 (0.70)	<0.001
Female	3.89 (0.31)	5.46 (0.36)	0.001	3.67 (0.30)	4.97 (0.35)	0.004	0.26 (0.06)	0.61 (0.12)	0.011	8.15 (0.41)	10.46 (0.40)	<0.001

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Guy GP Jr, Machlin SR2, Ekwueme DU3, Yabroff KR4.Prevalence and costs of skin cancer treatment in the U.S., 2002-2006 and 2007-2011. **Am J Prev Med. 2015**

FUTURE CONSIDERATIONS: Costs

	Tele-cobalt	Linac	PDR	HDR
Investm. incl.10y interest	1.968.750	3.106.250	565.250	670.250
staff in 10 y	690.000	810.000	78.000	573.000
service in 10 y	200.000	400.000	50.000	50.000
sources 10y	2x 250.000	100.000	30x120.000	30x120.000
total costs in 10 y	3.018.750	4.416.250	813.250	1.398.250
fractions/day	100	60	1/2	8
average nr. of fractions	25	20	1	4
effective nr. of pat./day	4	3	1/2	2
total no patients in 10y	8800	6600	1450	4400
overall cost per patient	$ 343	$ 669	$ 560	**$ 317**

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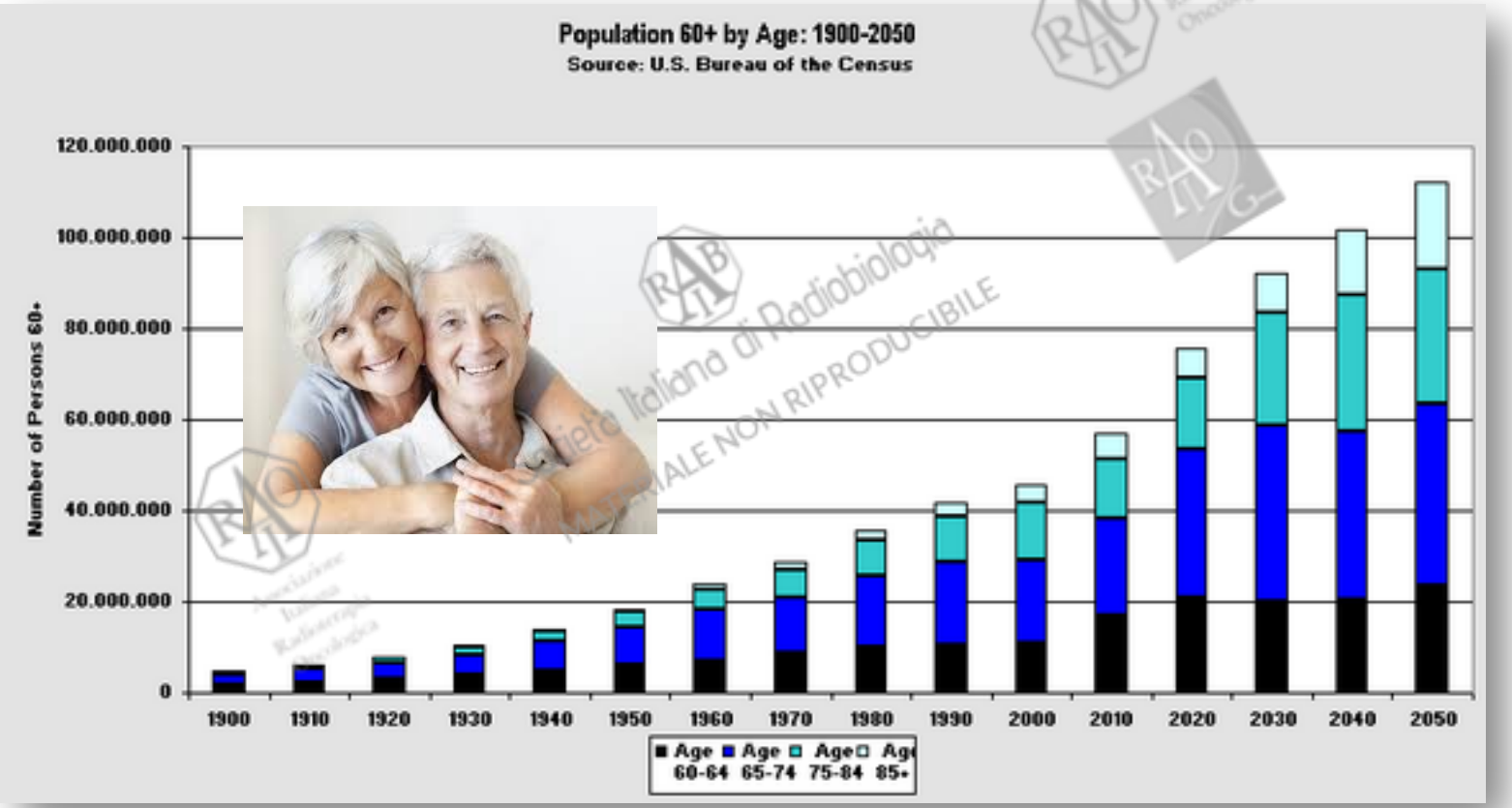
Courtesy of Prof. G Kovacs and E. Van´t Hooft

FUTURE CONSIDERATIONS: Age trend



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FUTURE CONSIDERATIONS

Incidence

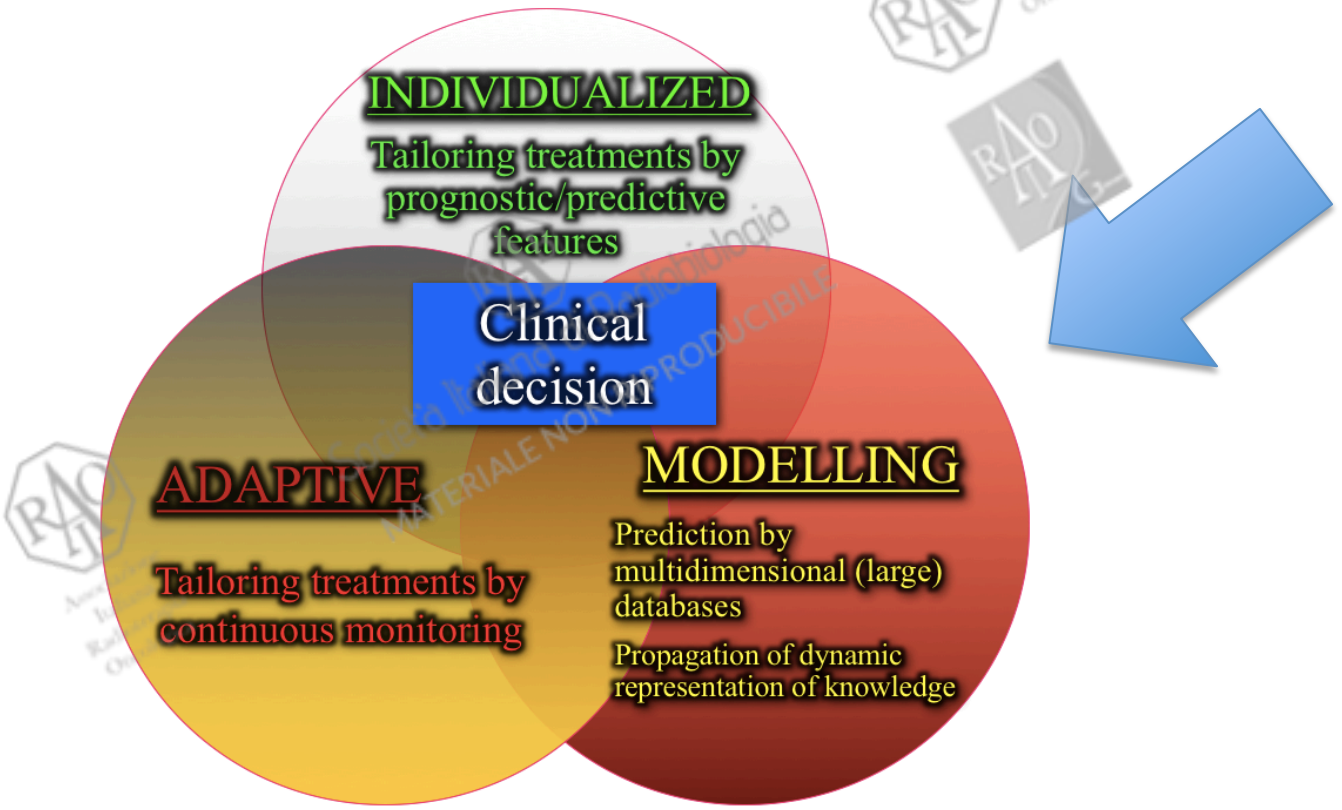
Age trend

Costs

Inter. RT Indications

- Courtesy of Prof. V. Valentini

CHOICE OF THE BEST THERAPY

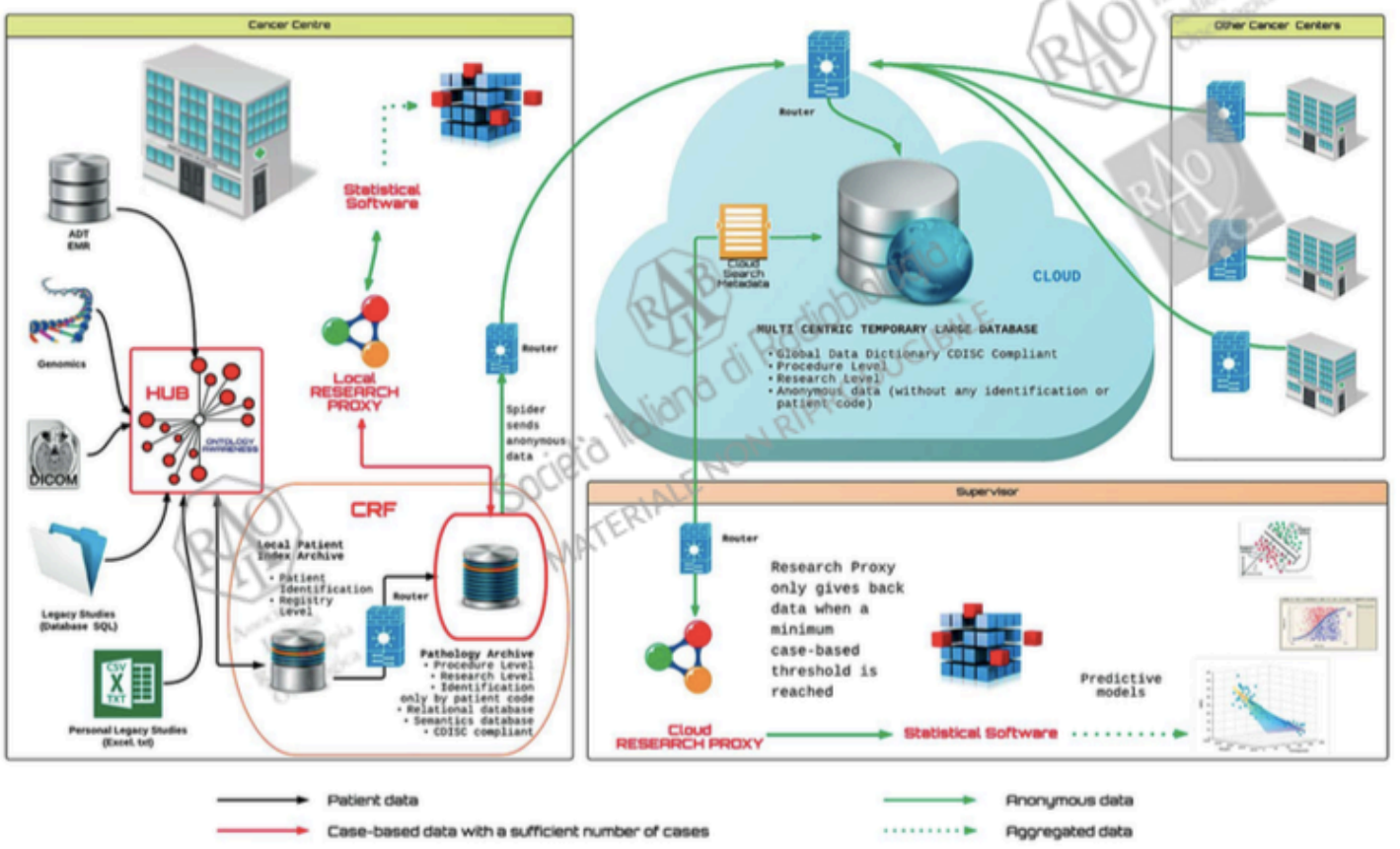


- **Courtesy of Prof. V. Valentini**

LARGE–DATABASE

COBRA (Consortium for Brachytherapy Data Analysis)

INTERDISCIPLINARY STANDARDIZED DATA COLLECTION SYSTEM FOR PATIENTS TREATED WITH INTERVENTIONAL RADIOTHERAPY



- Tagliaferri L, Kovács G, Autorino R, Budrukkar A, Guinot JL, Hildebrand G, Johansson B, Monge RM, Meyer JE, Niehoff P, Rovirosa A, Takàcsi-Nagy Z, Dinapoli N, Lanzotti V, Damiani A, Soror T, Valentini V. ENT COBRA (Consortium for Brachytherapy Data Analysis): interdisciplinary standardized data collection system for head and neck patients treated with interventional radiotherapy (brachytherapy). **J Contemp Brachytherapy. 2016**