

Nomenclatures

<ul style="list-style-type: none"> ■ Radiation Oncology ■ Radiation Therapy ■ Radiotherapy ■ X-ray therapy ■ “rays” ■ “ray” therapy 	<ul style="list-style-type: none"> ■ Radiology ■ Medical Oncology
<ul style="list-style-type: none"> • Radiation Oncologist • Radiotherapist 	<ul style="list-style-type: none"> • Radiation Therapist

RADIOTHERAPY

- Unit of measurement gray eg 60Gy or 6000cGy = 6000 Rad
- 1 Gy = absorption of 1 J of energy by 1Kg of matter

```

graph TD
    ONCOLOGY --> MedicalOncology[Medical Oncology]
    ONCOLOGY --> RadiationOncology[Radiation Oncology]
    Haematology --> MedicalOncology
    
```

Roles of Radiotherapy

- Curative Intent
 - Definitive (primary treatment)
 - Eg Lung, skin, anal, cervix cancer, lymphoma
 - Adjuvant
 - Post-operative eg breast, uterine, prostate cancer
 - Pre-operative eg rectal cancer
- Palliative
 - Control symptoms eg pain, obstructive, bleeding
 - Maintain/improve quality of life
 - Pre-emptive “strike”

Benign Conditions

<ul style="list-style-type: none"> ■ Arterio-venous Malformations (AVM) ■ Pituitary adenoma ■ Keloid scar ■ Plantar fasciitis ■ Hypertrophic ossification 	<ul style="list-style-type: none"> ■ Acne ■ Alkylosing Spondylitis ■ Fungal infection of scalp (<i>inea capitis</i>)
--	---

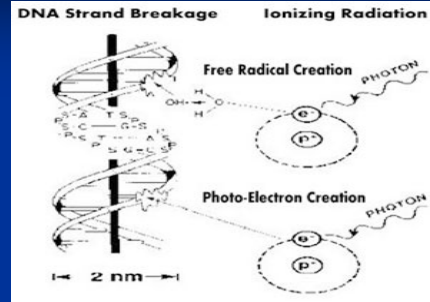
HISTORY

- 1895 - X-rays discovered (W Röntgen, Germany)
- 1895 – first attempt at therapy (breast cancer, Emil Grubbe, USA)
- 1898 – Pierre & Marie Curie discovered radium
- 1899 – first real proof that X-rays can cure cancer
- 1903 – first scientific description of the effect of radiotherapy (in lymphoma, Senn & Pusey, USA)
- 1951 – first Cobalt machine (Victoria Hospital, Canada)
- 1952 – first linear accelerator - LINAC (Stanford, California)
- 1973 – CT scan invented (Hounsfield, UK)
- 1990 – first use of CT scan & computers for IMRT/3DRT



Radium

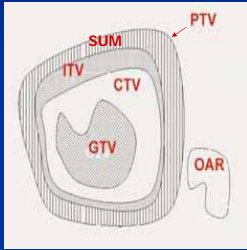
- Mined from uranium (Australia, Canada, Kazakhstan, USA, Congo)
- Very radioactive
- Luminescent
 - Early use in self-luminous paints for watches, clocks, aircraft switches, instrument dials
- Anti-cancer properties
 - Food additives (toothpaste, preservatives), hair cream
 - Spas (Japan)
- Late effects
 - Skin sores
 - Bone marrow
 - Anaemia
 - Bone cancer
 - Cancer
- Ceased 1940s



LINAC



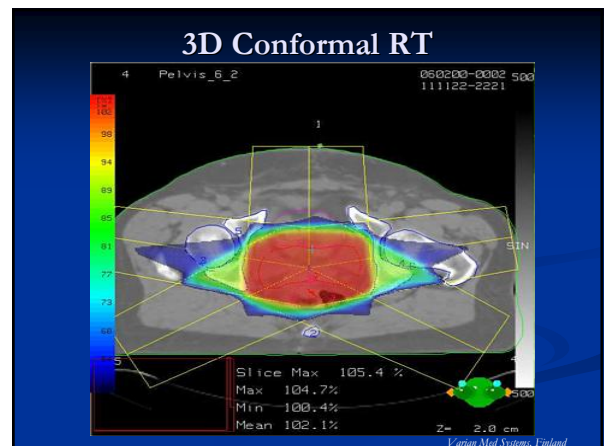
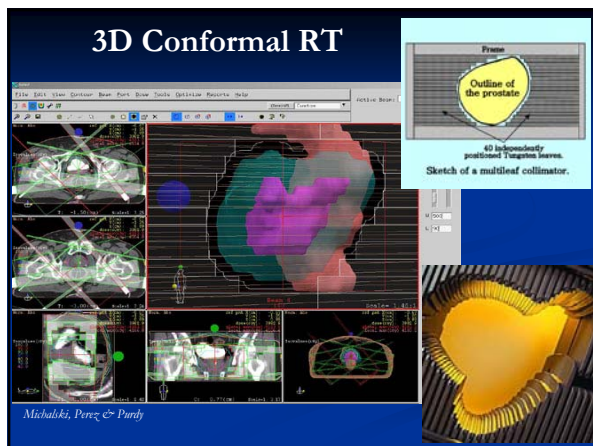
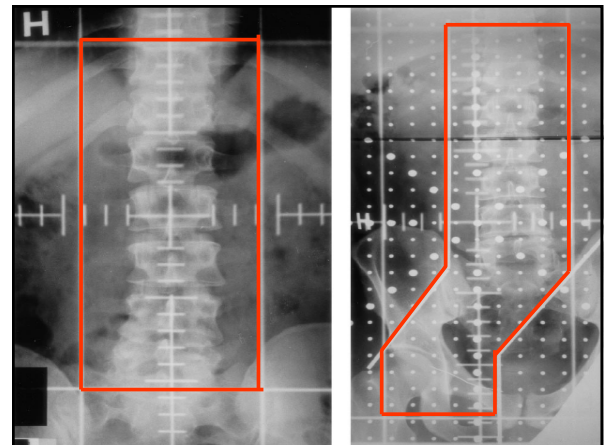
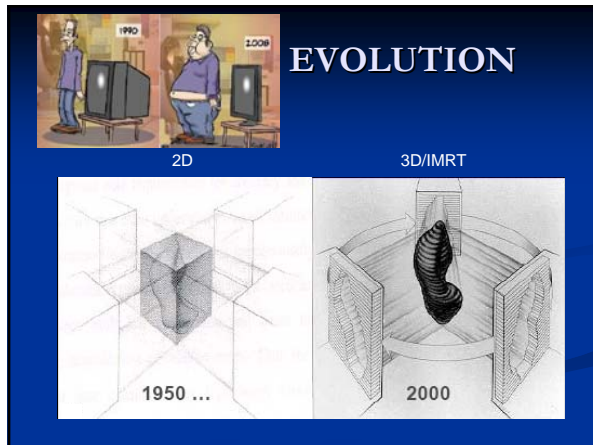
TARGET DEFINITION

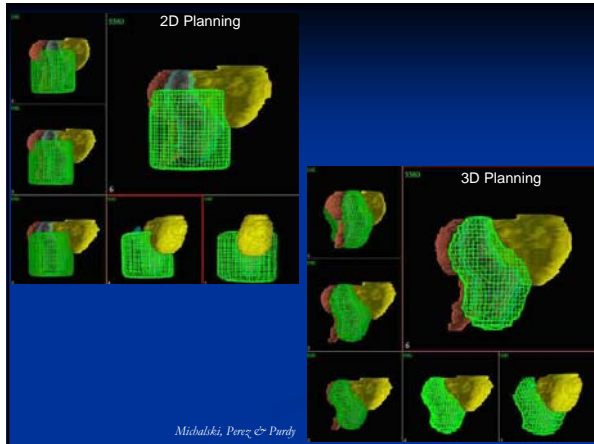


- GTV = demonstrable disease
- CTV = occult disease
- ITV = internal target motion (respiration, cardiac cycle, viscous motion)
- Set-Up Margin = external motion
- ITV + Set-up = PTV
- OAR = organ(s) at risk

Aims of Radiotherapy

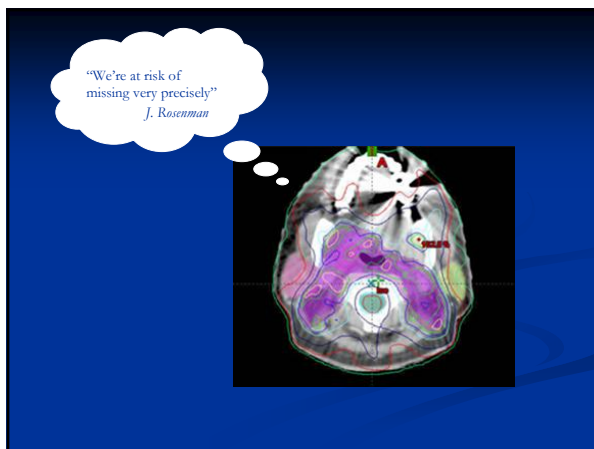
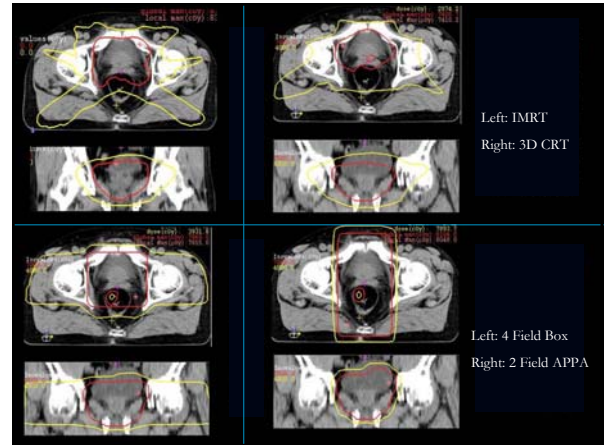
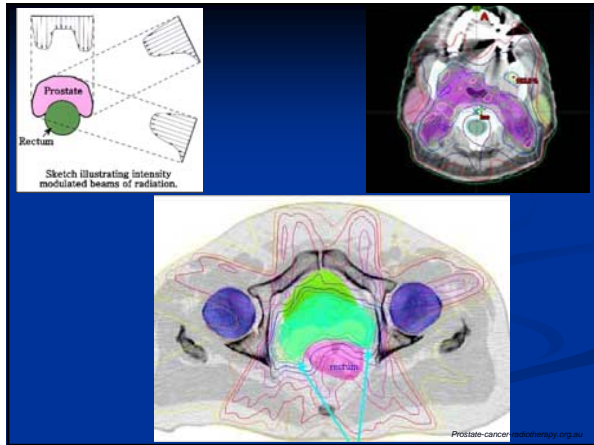
- Lethal dose to tumour/target
- Non-lethal dose to normal tissue
- Best outcome is to kill all cancer cells without causing any harm to patient
 - Compromise between benefit vs side-effects
 - Dependent on type & stage of illness
 - Patient's performance and fitness
 - Patient's wishes





IMRT

- Intensity-Modulated Radiation Therapy
- Utilises inverse planning algorithm
 - 3D/conformal = forward planning
 - Planner places treatment beams around patient, and then determines if the plan that is simulated complies with treatment prescription. If not, then process recommences, by trial & error, until objectives achieved
 - Inverse planning
 - A set of objectives is determined and the algorithm determines beam intensity and placement



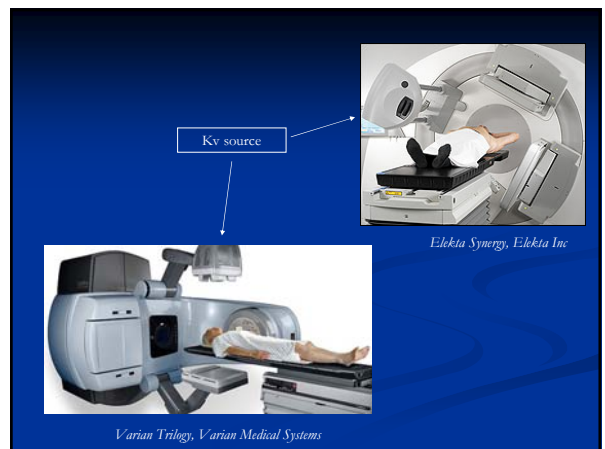
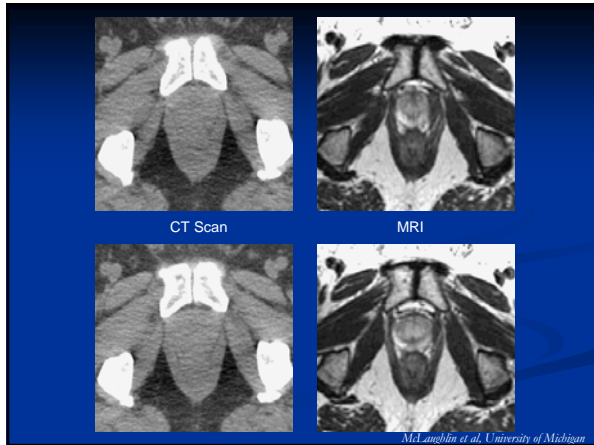
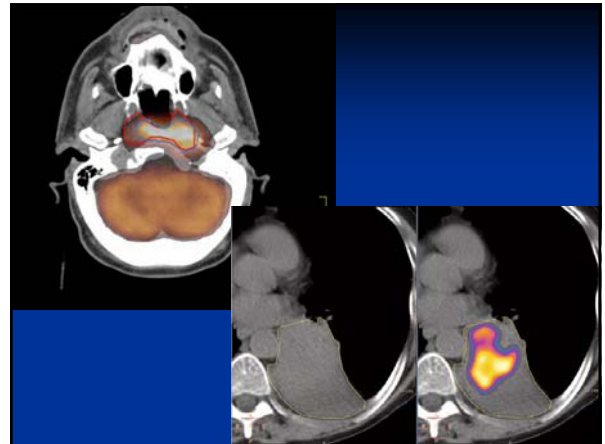
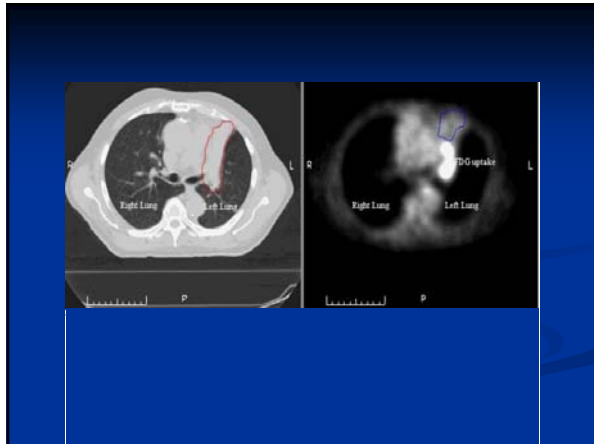
IGRT

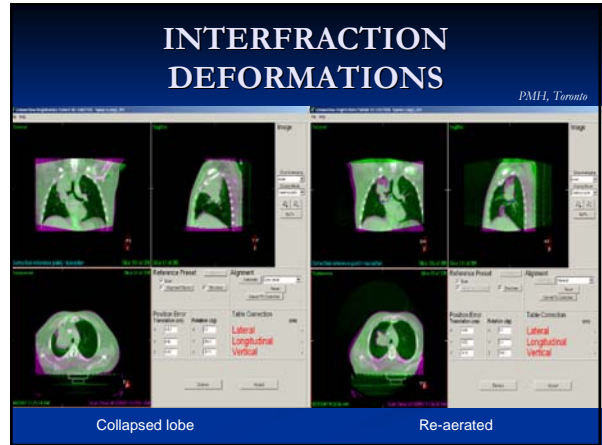
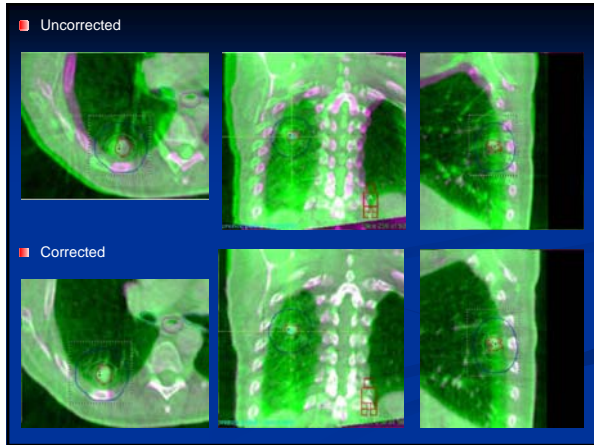
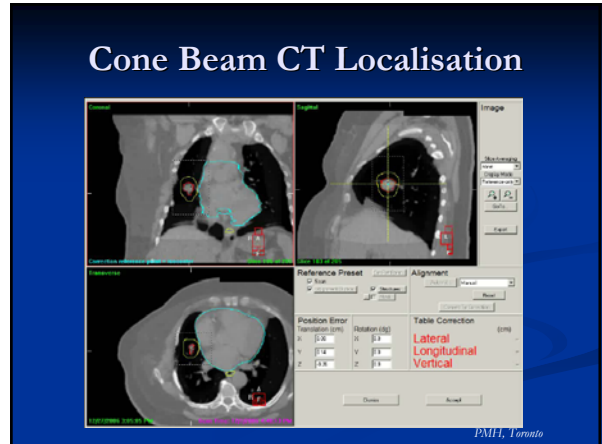
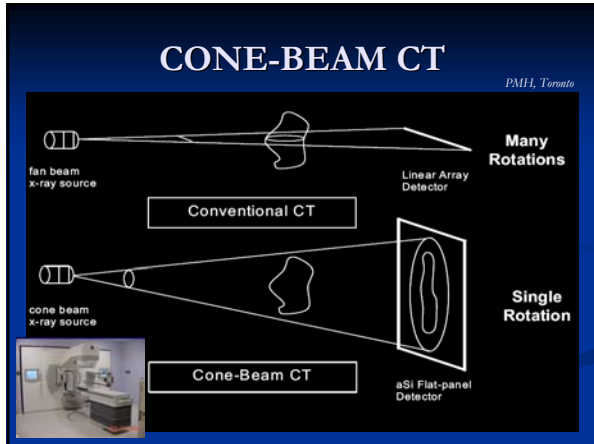
- Image-Guided RadioTherapy
- Image guidance
 - During treatment planning
 - During treatment delivery



"If you can't see it, you can't hit it.
If you can't hit it, you can't cure it"

HE Johns/W Powers



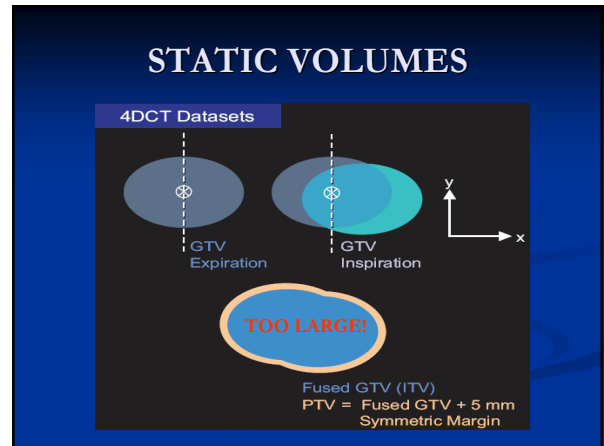
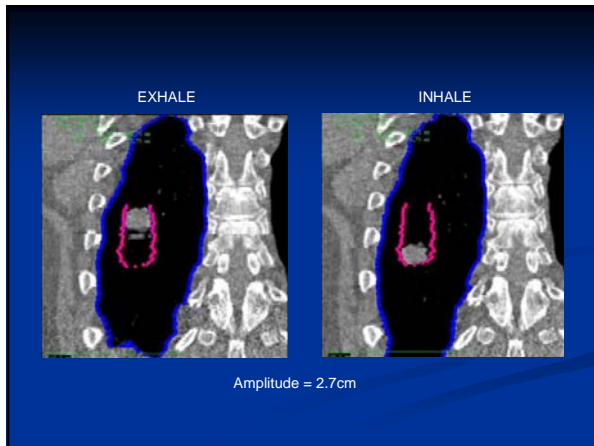


"If it's moving, you can't hit it.
If you can't hit it, you can't cure it"

J Battista

4D Radiotherapy





4DRT

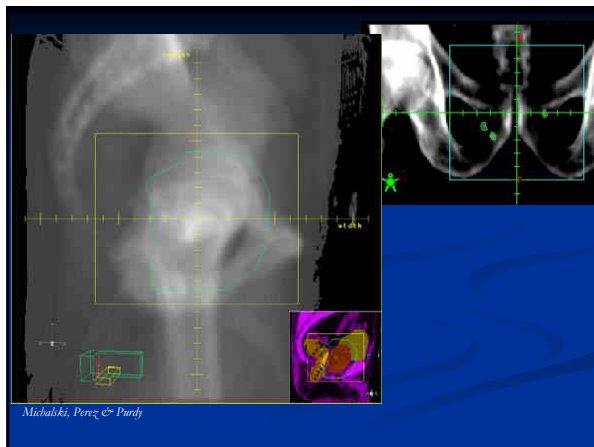
- Gate the beam
 - Monitor respiration
 - Direct (eg. Pneumotach)
 - Indirect (eg chest movement)
 - Fluoroscopic tracking
- Gate the patient
 - Breathing control

Varian RPM system

Fiducial Markers

caroncolony.com

radonc.uscd.edu



Ultimate Example of High Precision Radiotherapy

- Stereotactic Body RT
- Several clinical trials running
 - SPACE, CHISEL
- Typically over 3-6 fractions
- Radiobiologically more effective

PMH, Toronto

Accuray Cyberknife

Helical Tomotherapy

- “Helical arc IMRT” with image-guidance
- Highly conformal & precise
- Conformal “avoidance” of normal tissues

- Recently gained Medicare Benefit Schedule listing
- Plans for installation Peter MacCallum Tatterstalls Cancer Centre, Melbourne and Royal Brisbane Hospital

Aims of Radiotherapy

- Lethal dose to tumour/target
- Non-lethal dose to normal tissue

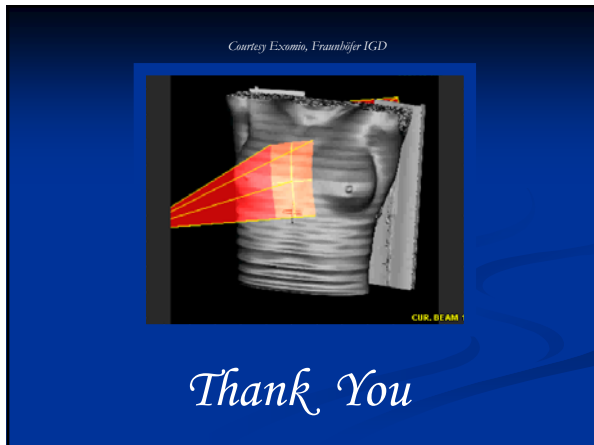
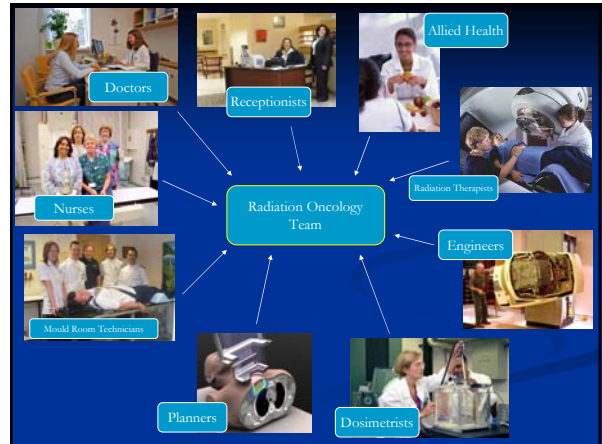
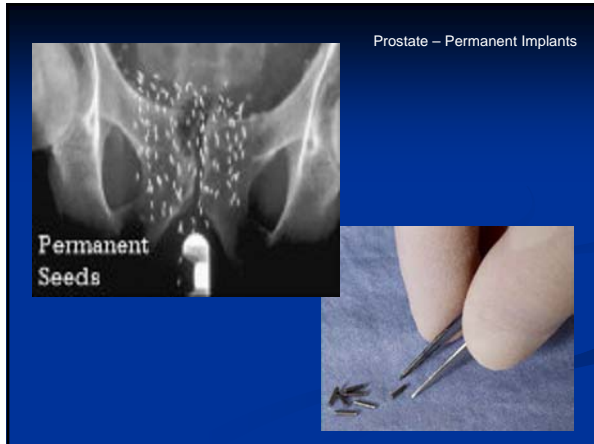
“Best outcome is to kill all cancer cells without causing any harm to patient”

BRACHYTHERAPY

- Internal radiotherapy
- “Brachy” Greek for short
- Types
 - Interstitial
 - Intracavitary
 - Intra-operative
- Tumour streams
 - Prostate
 - Cervix, endometrial, vagina
 - Breast
 - Head & Neck
 - Skin
 - Sarcoma, colorectal

Interstitial Prostate

Intra-operative Radiotherapy



Next week's lecture

Cancer clusters - fact or fiction?
 Associate Professor Tim Driscoll, The University of Sydney, NSW