Challenge and Scope of Radiation Oncology in Cancer Care
<table>
<thead>
<tr>
<th>Cancer in India</th>
<th>Current scenario (2000-05)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>800,000 new cases; 2,500,000 prevalent cases; 550,000 cancer deaths in a year</strong></td>
<td></td>
</tr>
<tr>
<td>✓ Relatively young cancer population as per the existent age pyramid</td>
<td></td>
</tr>
<tr>
<td>✓ Tobacco-related cancers-important concern (40% in men &amp; 25% in women)</td>
<td></td>
</tr>
<tr>
<td>✓ Cervix still the leading cancer in women across the country</td>
<td></td>
</tr>
<tr>
<td>✓ Breast cancer has overtaken cervix in urban metropolitan registries</td>
<td></td>
</tr>
<tr>
<td>✓ Only 337 teletherapy units in the entire country presently</td>
<td></td>
</tr>
<tr>
<td>✓ 2/3 rd of cancer patients need RT i.e. 5,00,000 patients / year</td>
<td></td>
</tr>
<tr>
<td>✓ Only 1/3 rd of these estimated patients actually receive RT (major shortfall)</td>
<td></td>
</tr>
</tbody>
</table>
Modalities of cancer therapy

Surgery

Radiation Therapy

Chemo Therapy

Radiation Therapy needed in > 60% of patients as part of
Radical or Definitive radiotherapy
Post-op adjuvant radiotherapy
Consolidation radiotherapy
Palliative radiotherapy
Five most common cancers account for almost half the total cases and deaths due to cancer in Indian men.

Cancer in India

Projections for future (2015-2020)

- Doubling of the cancer incidence in next 15 years
- Ageing population with consequent increase in cancer incidence & prevalence
- Huge shortage of RT infrastructure (equipment and human resource) to meet recommended norms
Multidisciplinary Team

- Surgical Oncologist
- Medical Oncologist
- Radiation Oncologist
- Pathologist
- Psychologist
- Dietician
- Patient

Supporting Services:
- Nursing services
- Voluntary organizations
- Dentist
- Radiologist
- Physiotherapist
- Occupational Therapist
- Stoma Clinic
- Medical Oncologist

Advances in RT

- Technological advances in treatment planning in external beam radiotherapy (teletherapy)
- Use of modern imaging (CT, MRI, USG, PET) crucial for modern day practice
- Computerization in computation and treatment delivery
- Better understanding of cancer biology, radiobiology and interaction with other modalities such as surgery, chemotherapy, immunotherapy
- Greater use of remote controlled brachytherapy, using radioisotopes directly around the tumour without any risk to personnel
- Generating quality clinical data as per appropriate scientific rigour
Conformal Radiotherapy

Excellent conformation
Multileaf collimators (MLC)
3D Conformal Radiotherapy (3D CRT)

- Large body of evidence including prospective and randomised data
- Prostate, head and neck cancers, GI cancers, paediatric malignancies
- Reduction of side effects
- Dose escalation and improved local control
- Chemotherapy can be combined concurrently
- Has already become the standard treatment in majority of the centres
Stereotactic radiosurgery

- Gamma knife
- Modified Linacs
- Proton beam

Firm immobilisation (stereotactic frames)
Treatment planning (dedicated workstations)
precise treatment delivery (high QA)
LA based Radiosurgery

Lutz IJROBP 1988; 14: 373-81
Stereotactic Conformal Radiotherapy (SCRT)

- Stereotactic frame
- Tight Conformation
- Computer planning
- Precise treatment delivery
# IMRT

**Intensity Modulated Radiotherapy**

- Advanced form of conformal radiotherapy, exciting
- Vary the intensity of beams in a non-uniform manner to achieve higher conformality
- Sophisticated computer algorithms required
- Wrought with complexities, stringent QA
CRT

Uniform intensity
Metabolic image-based Planning

Tremendous enthusiasm

PET used in cancers of lung, head & neck, cervix, brain

Biological target Volume (BTV)
IMRT for Head and neck cancers
a lot of potential; very exciting

Characteristics
Sparing of spinal cord
Sparing of parotid gland
Dose escalation possible
Daily verification

Electronic Portal Imaging Device (EPID)

Cone CT
Image guided Radiotherapy (IGRT)

Cone Beam CT Imaging

EPID

Cone Beam CT
3D Volume acquisition to construct 3D images
Tomotherapy

Tomolmage alignment
### Role of Radiotherapy for Common Cancers in India

- **Head & Neck squamous cell cancers (HNSCC)**
- **Carcinoma breast**
- **Carcinoma of uterine cervix**
- **Carcinoma esophagus**
- **Non small cell lung cancer**

*Constitute almost 80-85% of cancer burden*
Indications
- Early stage disease
- Inoperable (medical contraindications)
- Surgery is morbid
- As Organ preservation Protocol
- Combination of EBRT+Brachy
  - _______ EBRT alone
  - _______ Radical Brachy
HEAD & NECK CANCER

BRACHYTHERAPY

RADICAL

BOOST TO EBRT

PALLIATIVE/SALVAGE - Recurrent disease

RETREATMENT IN IRRADIATED AREAS - Second primary

FACTORS: Location of lesion
  Size < 4 cm
  Accessibility
  Proximity to cartilage or bones
Head & Neck Cancer: TMH Experience
RADICAL EXT. RADIOTHERAPY (n=568) 1990-1996

Local Control vs AJCC stage

P=0.0000

DINSHAW ET AL 2000
**LOCO-REGIONALLY ADVANCED HNSCC**

**Strategies to improve outcome**

- Chemoradiation
- Altered fractionation
- Radiation sensitizers
- Dose escalation using 3D-CRT or IMRT
**TMH Protocol HNSCC: Postoperative radiotherapy (PORT)**

**Primary site**
- Large tumor-T3, T4
- Close or positive margins
- Deeply infiltrative tumor
- High grade histology
- LVE & PNI

**Regional nodes**
- Bulky nodes N2, N3
- Extranodal extension
- Multiple lymph nodes
- Multiple level nodes

**Doses of PORT**
- Primary & Nodal sites: 50-60 Gy/25-30#/5-6 wks (reducing fields)
- R1 or R2 resection: 4-10 Gy boost to residual disease
**Radiotherapy in Locoregional Disease**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>All women who undergo Breast Conserving Surgery</td>
<td></td>
</tr>
<tr>
<td>Women undergoing MRM with tumour &gt; 5 cm and/or &gt; 3 axillary nodes +ve</td>
<td></td>
</tr>
<tr>
<td>Supraclavicular fossa RT if &gt; 3 axill. nodes +ve</td>
<td></td>
</tr>
<tr>
<td>Axilla only for known residual disease or sometimes incomplete axill. Surgery &amp; +ve nodes (not recommended)</td>
<td></td>
</tr>
</tbody>
</table>
## Radiation Therapy after BCT

### External Radiation

- Entire breast with adequate margin
- 6MV LA- 45 Gy/25#/5 wks
- Computerized treatment planning to ensure optimal dose homogeneity

### TUMOR BED BOOST

- Interstitial Brachytherapy (implant):
  - LDR Ir-192 : 15-20Gy
  - HDR Ir-192 : 10 Gy/1 #
- Electron:
  - Appropriate energy (9 to 16 MeV) according to tumour bed depth (clinical data, mammo, CT) to a dose of 15 Gy/6 #
Tangential portals
**Interstitial Brachytherapy (implant):**

- **Low Dose Rate (LDR) Ir-192:** 15-20 Gy
- **High Dose Rate (HDR) Ir-192:** 10 Gy/1 

**Electron:**

- Appropriate energy (9 to 16 MeV) according to tumour bed depth (clinical data, mammo, CT) to a dose of 15 Gy/6 

**Tumor Bed Boost**
Comparison of MRM vs BCT

OVERALL SURVIVAL

5yr-75%
10yr-70%
1980-1990

5yr-87%
10yr-77%
1980-2000
The role of Radiotherapy in carcinoma of uterine cervix

TREATMENT PATTERNS IN CARCINOMA CERVIX

- RT (85%)
- Sx (8%)
- Comb (7%)
STAGE IB & IIA

Type III Hysterectomy + Pelvic Lymphadenectomy

IB1: Radical Radiation Therapy

IB2/IIA: Concomitant CT+RT

Low risk
Observation

Intermediate risk
Pelvic Radiation

High risk
Concomitant chemo radiation
**STAGE IIB & IIIB**

**Para-aortic LN -ve**
- Concomitant chemo radiation (weekly cisplatin)

**Para-aortic LN +ve**
- Extended field RT + Concomitant CT (weekly cisplatin)
- Neoadjuvant CT (2-3 cycles) + Extended field RT
CA. CERVIX 1979-1994
STAGE IB & IIA (952 pts)
Disease free survival

TREATMENT MODALITY
- **Sx ALONE (303 PTS)**
- **PREOP RT + Sx (293 PTS)**
- **RT ALONE (356 PTS)**

STAGES IB & IIA (356 pts)
RADICAL RADIOTHERAPY REGIMEN
Disease free survival

Fractionation Regimens
- 40Gy/20/28(MLB at 20/10)
- 46Gy/23/35
- 50Gy/32/40(1.5Gy/#)

P = 0.15

Dec. 2004
STAGE IIB (1282 PTS)
RADICAL RADIOTHERAPY REGIMEN
Prospective Cohort Study

Disease free survival

Fractionation Regimens

- 40/20/28 (MLB AT 20 + 2 ICA)
- 50/25/35 (2Gy/# + 1 ICA)
- 50/25/35 (2Gy/# + 1 ICA)
- 50/32/40 (1.5Gy/# + 1 ICA)

Late Complications

<table>
<thead>
<tr>
<th>Conv. Field</th>
<th>Ext. Field</th>
<th>MLB40, 50/25#</th>
<th>MLB10, 40/20#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bladder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dec. 2004
Other sites where RT is used commonly

<table>
<thead>
<tr>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophagus</td>
</tr>
<tr>
<td>Lung</td>
</tr>
<tr>
<td>Prostate</td>
</tr>
<tr>
<td>Brain tumors</td>
</tr>
<tr>
<td>Anal canal/ Rectum</td>
</tr>
<tr>
<td>Soft Tissue Sarcomas</td>
</tr>
<tr>
<td>Lymphomas (HD &amp; NHL)</td>
</tr>
<tr>
<td>Penile cancers</td>
</tr>
<tr>
<td>Pediatric solid tumors</td>
</tr>
<tr>
<td>Urinary Bladder</td>
</tr>
</tbody>
</table>
Oncological Emergencies

- Cord compression
- SVC compression
- Brain Metastasis
- Impending fracture
- Tumor bleed
- Nerve root compression
- Hypercalcemia
- Tumor lysis syndrome
Preventive Oncology

- Early detection of cervical and breast cancer
- Down staging of common cancers
- Prevention of tobacco related cancers.
Palliative Care

Symptom relief

Psychosocial support

Teamwork and partnership

Hope

Honesty
### Growth of RT infrastructure in India over the years

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Tele-den/million</th>
<th>Tele-units</th>
<th>Co-60</th>
<th>LA</th>
<th>Cs-137</th>
<th>Brach units</th>
<th>LDR</th>
<th>HDR</th>
<th>MIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>10270000000</td>
<td>0.33</td>
<td>337</td>
<td>260</td>
<td>69</td>
<td>8</td>
<td>186</td>
<td>37</td>
<td>73</td>
<td>76</td>
</tr>
</tbody>
</table>

**Graphical Representation:**
- **Co-60:** 260 units
- **R-HDR:** 73 units
- **MIC:** 76 units
- **LA:** 69 units
- **LDR:** 37 units
- **Cesium:** 8 units

**Notes:**
- 1962-1986 -- 76 Co-60 & Cs-137 units (> 20 years old): Definitely need replacement
- 1987-1991 -- 35 Co-60 units (> 15 years old): Should be considered for replacement
- Pre 1991 LA -- 12 units (>15 years old): Could be considered for replacement

**Highlight:**
- **123/337 teletherapy units need replacement**
Distribution of Teletherapy Machines: India

December 2005

International norm: 2 machines/million population
* Previously existing RCC: 22
@ Recently recognized RCC: 3
$ Pending recognition RCC: 3
☼ Newly proposed RCC: 3
# Radiation Oncology Infrastructure

## Gap between demand and supply

### Equipment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Current Existing</th>
<th>Ideal Scenario*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(international norms)</td>
<td></td>
</tr>
<tr>
<td><strong>Tele-density</strong></td>
<td>0.33 per million population</td>
<td>2 per million population</td>
</tr>
<tr>
<td><strong>Tele-units</strong></td>
<td>337 (includes 76 units &gt;20 years old)</td>
<td>2000</td>
</tr>
<tr>
<td><strong>Brachytherapy</strong></td>
<td>186 (0.19 per million)</td>
<td>330 (0.33 per million population)</td>
</tr>
<tr>
<td><strong>Simulator</strong></td>
<td>41</td>
<td>1 per RT centre</td>
</tr>
<tr>
<td><strong>3-D TPS</strong></td>
<td>48</td>
<td>1 per RT centre</td>
</tr>
</tbody>
</table>
# Radiation Oncology Infrastructure

## Gap between demand and supply

### Personnel

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Current Existing</th>
<th>Ideal Scenario*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation Oncologist</td>
<td>700 (1 per 715 patients annually)</td>
<td>2000 (1 per 250 patients annually)</td>
</tr>
<tr>
<td>Medical Physicist</td>
<td>500 (1 per 1000 patients annually)</td>
<td>1250 (1 per 400 patients annually)</td>
</tr>
<tr>
<td>Dosimetrist</td>
<td>Nil</td>
<td>500 (1 per 1000 patients annually)</td>
</tr>
<tr>
<td>RT Technologist</td>
<td>700 (2 per MV unit)</td>
<td>8000 (4 per MV units)</td>
</tr>
</tbody>
</table>
Radiotherapy plays a very important role in the treatment of cancer.

Organ preservation protocols have made the role of Radiation Oncologist extremely important and central in the cancer care.

Radiation Oncologist are also important link in early detection, oncological emergencies and palliative care.

With advances in technology Radiation Oncology is becoming a very exciting branch.

With the increasing cancer burden there is need for more trained Radiation Oncologist in the country.