THE ROLE OF NUCLEAR MEDICINE IN SURGICAL ONCOLOGY

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WHAT IS NUCLEAR MEDICINE?
• It is the branch of medicine that utilises nuclear technology for the diagnosis and treatment of diseases.
PRINCIPLE OF NUCLEAR MEDICINE.

- It uses the principle that a certain radiopharmaceutical (tracer) will at a certain point in time have a preferential uptake by a particular body or tissue.
- This uptake is then imaged by the use of detectors mounted in gamma cameras or PET (positron emission tomography) devices.
WHAT IS PECULIAR ABOUT NUCLEAR MEDICINE?

- Unlike other radiation applications for medical use, nuclear medicine uses unsealed sources of radiation. The tracer is introduced into the body of the patient through several routes (oral, intravenous, percutaneous, intradermally or inhalation) and he/she becomes the source of radiation.

- This radiation can then be detected (for diagnostic use) or used to kill some selected unwanted body cells (therapeutic use).
ADVANTAGES OF NUCLEAR MEDICINE

- Ability to image the whole body in a single sitting at a comparably short time hence increased patient throughput.
- Minimal radiation burden to patients, personnel and environment—the dosages used are very small.
- Non-invasive
- Able to give information on cellular activity at an early stage.
DISADVANTAGES

- Uses very costly and sophisticated equipment.
- Requires highly trained personnel.
- Higher chances of radiation exposure since the source is unsealed. Radiation accidents are more likely to occur.
- Global shortages of radioactive elements especially molybdenum (Tc generation)

TYPES OF DIAGNOSTIC PROCEDURES DONE AT KNH

1. Whole body radionuclide (RN) bone scan
   - To detect skeletal metastases from cancers such as breast, lung, colon, thyroid, prostrate.
   - To detect the skeleton as the primary source of cancer.
   - To detect inflammatory conditions of the connective tissue including infections.
   - To detect degenerative joint diseases such as osteoarthritis.
   - To detect sport injuries such as stress fractures
   - To determine whether pain from a joint prosthesis is due to loosening or infection.
   - To detect areas of ectopic calcification
2. Radionuclide thyroid scan

- To determine the anatomical position of the thyroid gland
- To determine the functional status of the thyroid gland i.e. hypo or hyper thyroidism
- To determine possibility of cancer of the thyroid gland (“cold” areas)

3. Renal scans

- Renogram: will delineate the function of the kidney and the collecting system
- Renal perfusion studies: e.g., after kidney transplant
- Renal function: glomerular filtration rate (GFR)
- Renal anatomy: e.g., ectopic kidneys

4. **Myocardial perfusion imaging:** (MPI)
   - For diagnosis of coronary artery disease (CAD)
   - To differentiate between viable and non-viable myocardial infarction (MI) hence deciding on mode of therapy (surgery vs. medical intervention)
   - Surveillance for those patients known to be at risk of developing CAD e.g., diabetes
5. Lung perfusion studies: to detect pulmonary embolism.
6. Adrenocortical imaging: to detect phaeochromocytoma
8. Sentinel lymph node (SLN) mapping and lymphoscintigraphy: especially in breast cancer and melanoma
CHALLENGES

- Delays in procurement of radiopharmaceuticals: 99mTc from Holland, radio-iodine from South Africa
- Lack of awareness of the existing NM facilities by our colleagues and the public.
- Inadequate numbers of trained personnel
- Lack of PET device and PET/CT hybrid devices for image fusion due to the costs involved

ROLE OF NM IN SURGICAL ONCOLOGY

I. Primary staging and re-staging of tumours - will give guidance to surgical approaches
II. Radionuclide therapy – e.g. radioiodine, samarium-53, rhenium-186-HEDP, strontium-89
III. Adjuvant radioiodine thyroid ablation therapy after “near-total” thyroidectomy for differentiated thyroid carcinoma (DTC) – sometimes leading to cure
iv. Localisation of ectopic tumours- e.g. ectopic parathyroid adenomas, parasternal thyroid tumours, phaeochromocytoma

v. Diagnosis, therapy and follow-up of (1) neuroendocrine tumours (NETs) with the use of radiolabelled peptides of somatostatin analogues (2) phaeochromocytomas and other neuroblastomas with I$_{131}$-MIBG (metaiodobenzylguanidine).
 WHEN TO DO RN BONE SCAN IN PROSTATE CANCER

- RN bone scan remains one of the most sensitive techniques for detecting osseous metastasis. Conventional x-rays may be normal in 30% cases. The main indications for RN bone scan are;

1. PSA levels greater than 10ng/ml- below this level, skeletal metastases are less than 1%.
2. Advanced disease- incidence of bone Mets is 20% in stage 3, 10% in stage 2 and less than 5% in stage 1.
3. Symptomatic patients at whatever stage.
4. Suspicious x-rays at whatever stage.
5. To assess impact of therapeutic intervention.
Thyroid Cancer
Well differentiated

- Surgery
- Medical treatment
- Radio iodine therapy
## Survival

Cancer survival at 5 years

<table>
<thead>
<tr>
<th>Type of cancer</th>
<th>Breast</th>
<th>Lung</th>
<th>Prostate</th>
<th>Pancreas</th>
<th>Bladder</th>
<th>Naso</th>
<th>Cervix</th>
<th>Well differentiated Thyroid cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival 5 ys</td>
<td>48-60%</td>
<td>10-14%</td>
<td>60-80%</td>
<td>Less than 20%</td>
<td>5-44%</td>
<td>47-53%</td>
<td>5-95%</td>
<td>More than 95%</td>
</tr>
<tr>
<td>Survival 10 ys</td>
<td></td>
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<td>95%</td>
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Diagnosis: Histology

- Nodule
- Multi nodular goiter
  - Palpation, US, FNA, Thyroid scan
- Metastasis: Nodes or distant
- Systematic or fortuitous discovery: surgery of Graves
Surgery

- Surgery: first and fundamental time of the treatment

- Type of surgery depends on:
  - Pre surgical diagnosis
  - Extemporaneous histologic findings
  - Final histological findings
Medical treatment: aims

- Replacement therapy: Thyroxine
- Sub clinical hyperthyroidism: Low TSH (Feed Back, blocking TSH secretion) <0.1uU/ml
Radio iodine ablation: aims

- Destroy any thyroid remnant tissue in order to have an easy follow up: Undetectable Thyroglobulin, Ultrasound, Whole body scan
- Destroying microscopic cancer lesions
- Whole body mapping by the post therapeutical scan may detect previously unseen metastatic lesions
Radio iodine ablation therapy: prognostic impact

*Mazzaferri and Kloos, JCEM 2001*

Rate of relapses after total thyrodectomy

1182 patients, Medium follow up 16 years

Rate of relapses is 4 times more
Radio iodine ablation: Which is the prognosis impact?

Mazzaferri and Kloos, JCEM 2001

Incidences of metastases after total thyrodeectomy

1182 patients, Medium follow-up 16 years

Incidence of metastasis: 35% at 40 years!

Rate of relapses 5 times more
Radio iodine ablation: 
prognostic impact

Sawka, JCEM 2004
Meta-analysis of 23 Studies

Risk of metastasis at 10 years
After RAI or not

<table>
<thead>
<tr>
<th>Study</th>
<th>Radioiodine Ablation</th>
<th>Control</th>
<th>RD (95%CI Random)</th>
<th>Weight</th>
<th>RD (95%CI Random)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Papillary Cancer</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hong Kong (F) 2002</td>
<td>4 / 441</td>
<td>5 / 143</td>
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<tr>
<td>Zurich (Stg II: P)</td>
<td>0 / 43</td>
<td>0 / 94</td>
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<tr>
<td>Subtotal (95%CI)</td>
<td>4 / 487</td>
<td>5 / 197</td>
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<td>Test for heterogeneity chi-square = 1.13 df=1 p=0.28</td>
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<tr>
<td>Test for overall effect z=-1.17 p=0.2</td>
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<tr>
<td>02 Papillary and Follicular Cancer</td>
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<tr>
<td>Ohio, USAF 2001</td>
<td>2 / 230</td>
<td>34 / 789</td>
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<tr>
<td>03 Follicular Cancer</td>
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<td>Hong Kong (F) 2002</td>
<td>4 / 123</td>
<td>1 / 12</td>
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<td>Lowey (capsule: F/P)</td>
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<td>0 / 72</td>
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<tr>
<td>Zurich (Min inv. F)</td>
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<td>1 / 19</td>
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<tr>
<td>Subtotal (95%CI)</td>
<td>9 / 160</td>
<td>2 / 93</td>
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<td>Test for heterogeneity chi-square = 0.90 df=2 p=0.64</td>
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<td>Test for overall effect z=0.28 p=0.8</td>
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<tr>
<td>Total (95%CI)</td>
<td>15 / 677</td>
<td>41 / 1079</td>
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<td>100.0</td>
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</tr>
</tbody>
</table>

Test for heterogeneity chi-square = 3.51 df=5 p=0.62
Test for overall effect z=-3.63 p=0.0003

Risk Diminution of 10%
CLINICAL CASES
Miliaire pulmonaire de cancer thyroidien
SCINTIGRAPHIE OSSEUSE
SCINTIGRAPHIE OSSEUSE AU ⁹⁹ᵐTC-HMDP
MIBG

- NEUROBLASTOMAS
- NEUROEMBRYONAL tumors
Corps entier 1
Bone scan and ribs fracture