bone pain Therapy with Radionuclides-Palliative and otherwise

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President-Elect SNMMITS
Objectives

- Describe palliative bone therapy with SR 89 & SM153
- Describe bone therapy with Xofigo® Ra 223
- Review advances in imaging prostate cancer
Metastatic Bone Pain
Theoretical Mechanisms

- Osteoblastic activity
- Osteoclastic activity
- Chemical interaction
- Nerve involvement
# Bone Metastases

<table>
<thead>
<tr>
<th>Cancer</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>50 - 85%</td>
</tr>
<tr>
<td>Prostate</td>
<td>50 - 70%</td>
</tr>
<tr>
<td>Hodgkin’s Disease</td>
<td>50 - 70%</td>
</tr>
<tr>
<td>Thyroid</td>
<td>40%</td>
</tr>
<tr>
<td>Lung</td>
<td>30 - 50%</td>
</tr>
<tr>
<td>Renal</td>
<td>30 - 50%</td>
</tr>
</tbody>
</table>

58th World Health Assembly - Resolution

World Health Organization
May 2005

4 Components of Cancer Control
- Prevention
- Early Detection
- Diagnosis & Treatment
- Palliative Care
58th World Health Assembly - Resolution

Palliative Care

...that the provision of palliative care for all individuals in need is an urgent, humanitarian responsibility.
Goals of Palliative Care

- Control symptoms in patients with advanced disease
- Enhance quality of life

Perron, V., Schonwetter RS. Assessment and Management of Pain in Palliative Care Patients. Cancer Control 2001;8:15-24
Cancer Pain Facts

1990 National Hospice Organization cared for 200,000 patients; 1999 increased to 700,000 patients.

National Hospice and Palliative Care Organization - 2014 increased to 1.6-1.7 million.²

Pain affects >70% of cancer patients.

More than 36% of patients with metastatic disease have pain severe enough to impair function.

Perron, V., Schonwetter RS. Assessment and Management of Pain in Palliative Care Patients. Cancer Control 2001;8:15-24

Cancer Pain Facts

- Pain Affects
  - Quality of life
  - Independence of individuals requiring premature institutionalized
  - Psychological condition causing emotional devastation

OBJECTIVES

- Current strategies for management of painful osseous disease.
- Overview of various therapies.
- Focus on radionuclide therapies.
- Discuss advances in prostate cancer imaging.
Metastatic Bone Disease

Current Pain Management Strategy

- = Inadequate pain relief
+ = Adequate pain relief

Positive Bone Scan and Pain

Opioids Chemotherapy Bisphosphonates

Radiation Therapy

Radionuclides Surgery

Pain Medication F/U

Pain Medication F/U

Pain Medication F/U
OBJECTIVES

- Current strategies for management of painful osseous disease.
- Overview of various therapies.
- Focus on radionuclide therapies.
Painful bone cancer Disease Therapies

- Analgesics - NSAIDs and Opioids
- Hormonal therapy
- Bisphosphonates
- Chemotherapy
- Radiotherapy
- Surgical intervention
- Radionuclides
WHO Three-Step Analgesic Ladder

1. Non-Opioid +/- Adjuvant
2. Opioid +/- Non-Opioid +/- Adjuvant
3. Stronger Opioid +/- Non-Opioid +/- Adjuvant

Pain Persisting or Increasing
Analgesics

Step One

Non-opioids

- Aspirin
- Ibuprofen
- Naproxen sodium
- Choline magnesium trisalicylate
- Tramadol

Levy NEJM Oct 1996 335(15):1124
Analgesics

Step Two

- Opioids
  - Codeine
  - Propoxyphene
  - Hydrocodone
  - Oxycodone

- NSAIDs plus adjuvant therapy

Levy NEJM Oct 1996 335(15):1124
Analgesics
Step Three

- Opioids
  - Morphine
  - Oxycodone
  - Hydromorphone
  - Fentanyl

- NSAIDs plus adjuvant therapy

Levy NEJM Oct 1996 335(15):1124
Opioids
Side Effects

- Constipation
- Gastrointestinal distress
- Sedation
- Nausea and vomiting
- Cognitive dysfunction

Levy NEJM Oct 1996 335(15):1124
Opioids
Issues

- Fear of addiction
- Fear of withdrawal symptoms
- Inadequate pain control
Hormonal Therapy

- Goal is to shrink or stop the growth of cancer cells in bone and thereby reduce or get rid of bone pain.
- Removal of organ
- Drug therapies to keep hormones from promoting cancer growth
- Primary hormones are testosterone and estrogen.
Bisphosphonates

- Indicated for use in breast cancer and multiple myeloma
- Targets osteoclasts
- Indicated for osteolytic lesions
- Many breast cancer patients have lesions with both lytic and blastic components
Chemotherapy
Prostate Cancer

- Mitoxantrone hydrochloride
- Indicated for use in patients with advanced hormone refractory prostate cancer
- Administered in combination with corticosteroids
- Administered by I.V. infusion every 21 days
Radiotherapy
External Beam - Localized

- Primary treatment in patients with isolated or clustered lesions
- Partial response rates of up to 70%
- Typically given as 5-10 treatments over one or two weeks
- May take 2-3 weeks for full effect to occur
- Myelosuppression related to extent of marrow in radiation field
Radiotherapy

External Beam - Hemibody

- Treatment delivered to one half of the body
- Requires patient preparation and inpatient admission prior to treatment
- Response rates of about 70%
- Significant myelosuppression
- Significant potential for other organ toxicity
Radiotherapy
Local Field
Issues
- Requires multiple sessions
- Unmasking phenomena
- Myelosuppression can occur
- Collateral damage to non-target tissues
- Scarring and strictures
- Expensive
Surgery

- Often has to be extensive

- Removal of organ producing hormone

- Removal of one area of bone-only applicable to a single bony lesion or cluster.
Bone Pain Management

- Analgesics - NSAIDs and Opioids
- Hormonal therapy
- Bisphosphonates
- Chemotherapy
- Radiotherapy
- Surgical intervention
- Radionuclides
OBJECTIVES

- Current strategies for management of painful osseous disease.
- Overview of various therapies.
- Focus on radionuclide therapies.
Optimal Characteristics of a Therapeutic Radionuclide

- Particulate emission of an appropriate energy and range.
- Physical $T_\frac{1}{2}$ that approaches the biological $T_\frac{1}{2}$ of RPH in tumor.
- Selective concentration in bone lesions (maximize dose to bone and minimize marrow dose).
- Rapid blood clearance.
- Low extra osseous uptake.

Radionuclide Therapy

- Discuss the use of Sr89 & Sm153
- Introduce Xofigo® Ra-223 – prostate cancer
Radionuclide Therapy

Indications

- Indicated for relief of pain with confirmed osteoblastic metastatic bone lesions that enhance on bone scan
- For patients who cannot tolerate opioid analgesics
- Provides systemic relief of bone pain
- Administered single injection
Radionuclide Therapy

- Relief of pain in confirmed osteoblastic metastatic bone lesions that enhance on radionuclide bone scan within 4–8 weeks.
- Respondents may begin to notice the onset of pain relief in one week
- Targets multiple osteoblastic lesions at one time
- Life expectancy of at least 60 days
- Reversible myelosuppression allows for planning of other modalities
Radionuclide Therapy
Side effects

- **Myelosuppression is the most significant side effect**
  - Grade 0-2 in >90% patients
  - Nadir at 3-5 weeks
  - Platelets and WBCs tend to return to pretreatment values 8-12 weeks

- **Bone Flare**
  - Increase in bone pain
  - Within 72 hours of injection
Radionuclide Therapy

- Concentrates in areas of bone turnover in association with hydroxyapatite
- Irradiates the bone with Beta particles
- Average particle range in bone is 1.7 mm
- The mechanism of action of radiation in relieving bone pain is unknown
- Response rate 50-84%
Radiopharmaceuticals for Bone Pain Palliation

- Phosphorus-32
- Strontium-89
- Samarium-153 EDTMP
- Xofigo® Ra-233
### Physical Properties of Radioisotopes

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>$T_{1/2}$</th>
<th>Beta mE v max</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-32</td>
<td>14.3 days</td>
<td>1.7</td>
</tr>
<tr>
<td>Sm-153</td>
<td>1.9 days</td>
<td>0.81*</td>
</tr>
<tr>
<td>Sr-89</td>
<td>50.5 days</td>
<td>1.49</td>
</tr>
</tbody>
</table>

* Gamma 103 kev
Phosphorus-32

- First agent used
- Seldom used now
- Significant marrow toxicity
- Mean range 3 mm
Phosphorus–32 Sodium

- Clear, colorless solution
- Bone palliation, polycythemia vera, and acute leukemia.
- 4 mCi about 100 rads to bone marrow
Phosphorus-32 Chromate

- Bluish, green colloidal suspension
- For malignant effusion
- Instilled directly into body cavity
- Usually 3-6 mCi administered.
- Do a 99mTc-sulfur colloid scan before
<table>
<thead>
<tr>
<th>ORGAN</th>
<th>$^{32}\text{P}$</th>
<th>$^{89}\text{Sr}$</th>
<th>$^{153}\text{Sm}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone Surface</td>
<td>37</td>
<td>17.0</td>
<td>6.8</td>
</tr>
<tr>
<td>Red M arrow</td>
<td>7.6</td>
<td>11.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Lower Bowel W all</td>
<td>0.001</td>
<td>4.7</td>
<td>0.01</td>
</tr>
<tr>
<td>Bladder W all</td>
<td>0.001</td>
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<td>1.0</td>
</tr>
<tr>
<td>Testes</td>
<td>0.001</td>
<td>0.8</td>
<td>0.01</td>
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<td>0.001</td>
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<td>0.001</td>
<td>0.8</td>
<td>-</td>
</tr>
<tr>
<td>Kidneys</td>
<td>0.001</td>
<td>0.8</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Strontium-89 Chloride

- First studied in early 1940s
- Not applied to human studies till 1970s – approved in 1993
- $T_{1/2}$ 50.5 days
- Beta Max 1.49 mE\text{v}
- Mean range in tissue 2.4 mm
Strontium-89 Chloride Pharmacokinetics

- Rapid blood clearance
- Excretion 2/3 renal/urinary
  - Greatest first 48 hours
  - Complete clearance 14 days
- 1/3 Fecal
**Strontium-89**

**Dosage and Administration**

- Recommended dose of 40-60 uCi/kg. Standard dose of 4 mCi
- Dose should be calibrated prior to patient administration
- Administer over a 1-2 minute interval through an established i.v. line
- Do not dilute the dose
- Suitable for outpatient administration
Strontium-89 Patient Selection

- Accurate assessment of pain is essential
- Sr-89 is not indicated for spinal cord compression
- Efficacy in osteolytic lesions is unknown
- Will not affect pain from non-skeletal sources
  - Soft tissue tumors/invasion
  - Neuropathic pain
- Platelets >60,000/mm³; WBC >2400/mm³
- Life expectancy greater than 60 days
Strontium-89
Onset of Response

- Onset of pain relief 7-21 days week
- Flare reaction
- Mean duration of relief 6 months
Stronitum-89
Hematologic Response

- Platelets decrease 15-30% within 5-6 weeks
- WBCs decrease 20% within 2 weeks.
- Platelets & WBCs recover 10-12 weeks.
- Blood counts monitored weekly 12 weeks or until recovery of adequate bone marrow function
**Strontium-89**

**Bone Dosimetry**

- Absorbed bone dose 74 rads/mCi

- Patients with extensive metastases can have retention of 10% of the dose remaining at 100 days.

Guidelines for the Therapeutic Administration of Sr-89. *Dept of Human Services Victoria State Government.*
## Strontium-89 Radiation Emission Data

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Energy (keV)</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>554</td>
<td>0.01%</td>
</tr>
<tr>
<td>Beta</td>
<td>1.43</td>
<td>100%</td>
</tr>
</tbody>
</table>
Sr-89 therapy within last 3 months

Spinal cord compression.

Platelet count < 60,000/mm³

WBC < 2,400 mm³
Strontium-89
Shipping and Storage

- Vial is shipped in a transportation shield with approximately 3 mm of lead.

- The vial and contents should be stored in its transportation container at room temperature (59-77°F, 15-25°C).
Strontium-89
Storage and Disposal

- Stored in its transportation container.

- Disposal of Sr-89 should be controlled by licensed individuals authorized to use radiopharmaceuticals.
Strontium-89
Quantity and Concentration

- Sr-89 is supplied in 4.05 mCi in a 4 ml volume per 10 ml vial, containing 10.9 to 22.6 mg of strontium chloride per ml.

- This is a single use vial.
Strontium-89
Dose Preparation

- Keep at room temperature

- Expiration occurs 28 days post calibration.

- Stability studies show no change in any of the product characteristics.
Samarium-153 EDTMP

- Radiopharmaceutical discovered at the University of Missouri - Columbia
- Sm 153 produced by thermal neutron irradiation of enriched Sm 152 oxide
- Complexed with EDTMP, a chelating agent with an affinity for bone
- Mean range of 0.55 mm
Samarium-153 EDTMP
Pharmacokinetics

- Rapid renal clearance
- Less than 1% of the dose remains in the blood at 5 hr
- Skeletal uptake of 65% +/- 15% of the dose
- Decreased urinary excretion and increased skeletal uptake in patients with greater numbers of bone metastases
Samarium-153 EDTMP
Patient Preparation

- Patient well hydrated.
- Rapid clearance from plasma <1% in 5 hours
- Incontinent patients catheterized
- Patients should flush toilet several times 12 hours post administration
Samarium-153 EDTMP
Dosage and Administration

- Dose of 1.0 mCi/kg
- Dose should be calibrated prior to patient administration
- Administer over a 1 minute interval through an established i.v. line
- Do not dilute the dose
- Suitable for outpatient administration
Samarium-153 EDTMP

Patient Selection

- Accurate assessment of pain is essential
- Sm-153 EDTMP is not indicated for spinal cord compression
- Efficacy in osteolytic lesions is unknown
- Will not affect pain from non-skeletal sources
  - Soft tissue tumors/invasion
  - Neuropathic pain
- Platelets >60,000/mm³, WBC >2,400/mm³
- Life expectancy greater than 60 days
Samarium-153 EDTMP
Onset of Response

- Patients may begin to notice the onset of pain relief 1 week after administration

- Flare reaction within 72 hours
Samarium-153 EDTMP
Hematologic Response

- Platelets and WBC decrease
  - nadir of 40-50% of baseline values within 3-5 weeks
- Return to pretreatment levels by week 8
- Blood counts monitored weekly for at least 8 weeks or until recovery of adequate bone marrow function
Samarium-153 EDTMP
Bone Dosimetry

- Normal bone surface receives 25 rads/mCi
  25 rads/mCi X 70 mCi = 1750 rads

- Osteoblastic lesions can accumulate five times as much Sm-153
# Samarium 153 Radiation Emission Data

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Energy (keV)</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>640</td>
<td>30%</td>
</tr>
<tr>
<td>Beta</td>
<td>710</td>
<td>50%</td>
</tr>
<tr>
<td>Beta</td>
<td>810</td>
<td>20%</td>
</tr>
<tr>
<td>Gamma</td>
<td>103</td>
<td>29%</td>
</tr>
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</table>
Samarium-153 EDTMP

Contraindications

- Sm-153 EDTMP is contraindicated in patients who have known hypersensitivity to EDTMP or similar phosphonate compounds
- Spinal Cord compression – untreated
- Platelet count less than 60,000/mm³
- WBC less than 2,400/mm³
Samarium-153 EDTMP

Clinical Pharmacology

- Has an affinity for bone and concentrates in areas of bone turnover
- Lesion to normal uptake ratios similar to radionuclide bone scans
- Urinary excretion as the intact complex
Samarium-153 EPTMP
Shipping and Storage

- Shipped frozen in unit dose glass vials
- Must be stored frozen at -10°C to -20°C.
Samarium-153 EDTMP

Storage and Disposal

- Store frozen in a lead shielded container

- Disposal of Sm-153 should be controlled by licensed individuals authorized to use radiopharmaceuticals
Samarium-153 EDTMP
Quantity and Concentration

- Sm-153 is supplied in 100 mCi (2ml) and 150 mCi (3ml) unit dose vials

- Concentration is 50 mCi/ml at calibration
Samarium-153 EDTMP

Dose Preparation

- Thaw at room temperature
- Administer within 8 hours of thawing
- Expiration occurs 48 hours post calibration or 8 hours after thawing, whichever occurs first
- Do not dilute dose
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<td>0.02</td>
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VA San Diego Healthcare System
Clinical Worksheet for 153 Samarium (Quadramet) Therapy

Age ___________ Sex ___________ Height ___________ Weight ___________

**Patient Selection Criteria Met**
1. Bone metastasis has been confirmed by
   (a) Biopsy of confirmed metastatic site   Yes  No
   (b) Known primary plus radiologic evidence of bone mets  Yes  No
   (c) Unknown primary but confirmed secondary bone mets and x-ray evidence of bone mets  Yes  No
2. Bone scan performed within one month of Rx  Yes  No
3. Life expectancy of patient more than 60 days  Yes  No
4. Patient not responding well to conventional therapy
   (a) Patient had surgery   Yes  No
   (b) Patient had radiotherapy to ___________________________  Yes  No
   (c) Patient had hormonal therapy _________________________  Yes  No
   (d) Patient requires narcotic analgesic _________________  Yes  No
5. Patient blood count before treatment
   WBC > 2400 _______________
   Platelet > 60,000 ___________
6. Female patients only:
   Pregnancy ruled out? Yes ___ No ___ By: __________
   Urine pregnancy (if needed) ___________ on ____________, 20_____
   Patient advised of risks to fetus and advised not to become pregnant for at least six months? Yes ___ No ___
   Is patient breast feeding? Yes ___ No ___ Small children at home ___
7. Pre-therapy status
   (a) Hgb/Hct ___/___ Date___________________
   (b) WBC __________________
   (c) Platelet __________________
Other Lab:
Pain sites:   ________, ________, ________, ________
Pain score:   ________, ________, ________, ________

8. Follow-Up

<table>
<thead>
<tr>
<th>Date</th>
<th>Hgb/Hct</th>
<th>WBC</th>
<th>Platelet</th>
<th>Pain Site/Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd week</td>
<td>_______</td>
<td>______</td>
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<tr>
<td>4th week</td>
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<td>6th week</td>
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<td>8th week</td>
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<td>10th week</td>
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<td>12th week</td>
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<tr>
<td>14th week</td>
<td>_______</td>
<td>______</td>
<td>______</td>
<td>______</td>
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<tr>
<td>16th week</td>
<td>_______</td>
<td>______</td>
<td>______</td>
<td>______</td>
</tr>
</tbody>
</table>
Radiation Synovectomy

For the treatment of inflammatory synovial disease
- Rheumatoid arthritis
- Osteoarthritis – to some extent

Attractive alternative
- Chemical synovectomy
- Surgical synovectomy
Radiation Synovectomy

- Single injection of beta-emitter directly into synovium
  - Control inflammation
  - Ablate inflammation
- Typically colloids or large aggregates
  - Not typically used in US
  - Leakage issues
- Agents of choice Sn-117m, Sm-153 & Er-169 with appropriate sized particles.

Xofigo®
Xofigo®

Radium 223 T ½ 11.4 days
- Alpha emitter 95.3%
- Beta 3.6%
- Gamma 1.1%

Patients with castration-resistant prostate cancer

Symptomatic bone mets - no distant mets
- 90 % pts with advanced prostate cancer only bone mets

Package insert Xofigo 2013

Xofigo®
mechanism of action

- Mimics calcium
- Forms complexes – hydroxyapatite of increased uptake – i.e. bones mets
- Alpha LET = 80 kev/micrometer
  - High frequency of double-strand DNA breaks in adjacent cells
  - High anti-tumor affect
  - Alpha particle range is 100 micrometers

Package insert Xofigo 2013
Alpha Particle
50-80 micron range
5-8 MeV

Beta Particle
1-10 mm range
0.1-1 MeV

*Tu denotes tumor (cancer) cells

Picture courtesy of MSKCC
Xofigo®

**Dosing – side effects**

- 6 doses – 4 weeks apart
- IV over 1 minute
- Dose is 1.36/uCi/kg (70 kg man = 95 uCi)
- Side effects >10%
  - Nausea, diarrhea, vomiting, & peripheral edema
  - Lab side effects – Lymphocytopenia, Leukopenia, Thombocytopenia, neutropenia

Package insert Xofigo 2013
Xofigo®

**Biodistribution & Elimination**

- Rapidly clears blood – bone – intestine
  - 15 min post – 20% left in blood
  - 4 hrs – 4%
  - 24 hrs <1%

- **Elimination**
  - 63% excreted within 7 days
  - Fecal excretion 48hrs – 13%
  - Urine excretion 2%

- **Not metabolized**

Package insert Xofigo 2013
ALYSMPCA Trial

A Double-Blind, Randomized, Multiple Dose, Phase III, Multicentre Study of Alpharadin in the Treatment of Patients With Symptomatic Hormone Refractory Prostate Cancer With Skeletal Metastases

Radium-223 chloride (Alpharadin, manufactured by Algeta in partnership with Bayer).
ALYSMPCA Trial

- 809 prostate cancer patient resistant to hormone treatment with 2 or more bone mets
- Radium 233 – significantly increased survival 14 months compared to 11.2 months
- Prolonged the time to first skeletal-related events 13.5 vs 8.4 months.
ALYSMPCA Trial

- Significant improvement of 3 of 4 skeletal-related events
  - Pathologic bone fx
  - Spinal cord compression
  - External beam radiation to bone

- Overall rate of grade 3 and 4 adverse events was lower with the placebo group vs treatment group.
"What you're doing here is very different from all the other bone-targeted agents: You are actually killing cancer cells," Dr. Sartor commented. "The other bone-targeted agents – samarium, strontium, denosumab, and zoledronic acid are the four FDA-approved ones – none of them kill cancer cells like this one does. This is mechanistically distinct."

Sator, Oliver MD. Medical Director, Tulane Cancer Center
ASCO Genitourinary cancer symposium 2012
Bone Pain Management

- Analgesics - NSAIDs and Opioids
- Hormonal therapy
- Bisphosphonates
- Chemotherapy
- Radiotherapy
- Surgical intervention
- Radionuclides
Evidence for Improving Palliative Care at the End of Life: A Systematic Review

Published Annual of Internal Medicine

15 January 2008

Clinical Guidelines

Literature review of 24,423 titles find 6381 relevant abstracts

Reviewed 1274 articles to identify 33 high quality systematic reviews and 89 relevant intervention studies.

Strong evidence from consistent randomized trials supports treating cancer pain with nonsteroidals, opioids, radionuclides and radiotherapy. Less consistent evidence supports the use of biophosphonates for pain.

The Future

Therapies that target the specific molecular changes that cause cells to become cancerous and processes that are required for continuous cancer cell growth and survival are now part of our therapeutic arsenal. To date, the FDA has approved approximately 30 molecularly targeted agents for cancer-related indications...

National Cancer institute Website accessed 11/13/12
The future

Through The Cancer Genome Atlas (TCGA) project (http://cancergenome.nih.gov/), a joint effort of the National Cancer Institute and the National Human Genome Research Institute, we will greatly expand our understanding of the genetic basis of more than 20 cancers that affect adults and identify specific molecular changes that can be targeted for the development of new treatments or exploited to detect cancer earlier or prevent its occurrence.
Another project, Therapeutically Applicable Research to Generate Effective Treatments (TARGET) (http://target.cancer.gov), will use a similar approach to identify molecular changes that lead to a variety of cancers that affect children.
Prostate Cancer

- **PSA (Prostate Specific Antigen)**
  - After therapy or surgery should be low or non-existent
  - best way s/p treatment
  - Detect early recurrence
    - **Biochemical recurrence**
      - PSA >0.2 – 0.4 ng/dl
    - **PSA doubling time (PSA dt)**
      - Shorter the time the more aggressive the cancer

Picchi, M. Castellucci, P. Clinical Indications of 11C-Choline PET/CT in Prostate Cancer Patients with biochemical relapse. Theranostics 2012:2(3)313-317. doi:10.7150/thno.4007
Prostate Cancer

- Conventional Imaging (bone scan, CT or MRI)
  - Not good PSA < 5 ng/dl
  - Or PSA dt of > 10 months
- CI sensitivity of 11% mean PSA 23 ng/dl

Picchi, M. Castellucci, P. Clinical Indications of 11C-Choline PET/CT in Prostate Cancer Patients with biochemical relapse. Theranostics 2012:2(3)313-317. doi:10.7150/thno.4007
C-11 Choline PET

Verses FDG PET – PSA mean 6.57 ng/dl
- C11 choline Pet – 47%
- FDG Pet – 27%

Verses PSA
- < 1 ng/dl = 36%
- 1- <2 ng/dl = 43%
- 2 -<3 ng/dl = 62%
- > or = 3 ng/dl = 73%

Picchi, M. Castellucci, P. Clinical Indications of 11C-Choline PET/CT in Prostate Cancer Patients with biochemical relapse. Theranostics 2012:2(3)313-317. doi:10.7150/thno.4007
Picchi, M. Castellucci, P. Clinical Indications of 11C-Choline PET/CT in Prostate Cancer Patients with biochemical relapse. Theranostics 2012:2(3)313-317. doi:10.7150/thno.4007
C – 11 choline

- Cyclotron produced
- 20 minute T 1/2

Picchi, M. Castellucci, P. *Clinical Indications of 11C-Choline PET/CT in Prostate Cancer Patients with biochemical relapse*. Theranostics 2012:2(3)313-317. doi:10.7150/thno.4007
Comparison of 11C-choline to 18F-FACBC

- Studies performed within 1 week of each other
- PSA at least 2.0 ng/dl above nadir
- Absolute PSA level of 0.3 ng/dl or > after prostatectomy

FIGURE 1. 18F-fluciclovine axial cut (A, fusion; B, CT; C, PET; D, MIP) showing increased uptake in 1 small positive interaortocaval lymph node (arrow). Corresponding 11C-choline axial cut (E, fusion; F, CT; G, PET; H, MIP) resulted completely negative.
FIGURE 2. 18F-fluciclovine axial cut (A, fusion; B, CT; C, PET; D, MIP) showing increased uptake in the prostatic bed, consistent with a local relapse (arrow). Corresponding 11C-choline axial cut (E, fusion; F, CT; G, PET; H, MIP) resulted completely negative.

18F-Fluciclovine PET/CT for the Detection of Prostate Cancer Relapse: A Comparison to 11C-Choline PET/CT.
18F-Fluciclovine PET/CT for the Detection of Prostate Cancer Relapse: A Comparison to 11C-Choline PET/CT.
Conclusion

- Palliative bone therapy with SR 89 & SM 153 decreasing nationwide
- Bone therapy with Xofigo® Ra 223 increasing
  - Challenge to get patient referred sooner
- Review advances in imaging prostate cancer are very promising and exciting.
Palliative Treatment of Painful Bone Cancer with Radionuclides

Conclusion

This therapy, like many other things in Nuclear Medicine, is underutilized.
THANK YOU
THANK YOU
Thank you