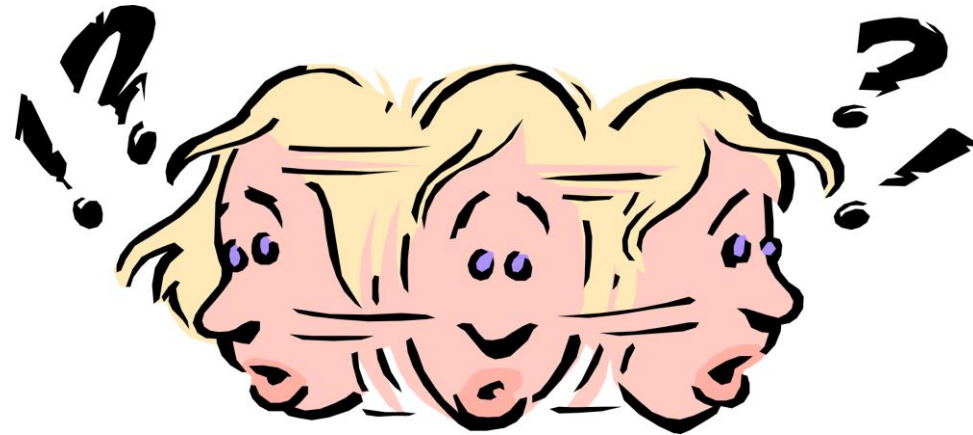

Advances in Radioisotope Medical Applications

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Disclosures

- No financial disclosures
- This is my perspective from a clinician running a research program
- Prioritized by demand in the clinic, not how they are produced or their availability



How I approached this talk

- Frequency of use: Tier 1 (common) Tier 2 (uncommon) Tier 3 (Research)
- Within each tier:
 - SPECT diagnostics
 - PET diagnostics
 - Therapeutics

^{99m}Tc

Gamma emitter

6 hour half life

^{99}Mo \rightarrow ^{99m}Tc Generator

Multifunctional isotope is the backbone of Nuclear Medicine
Bone scans, liver scans, biliary scans and numerous other scans
New agents are being developed with ^{99m}Tc



^{111}In

Gamma emitter
67 hour half life
Cyclotron produced

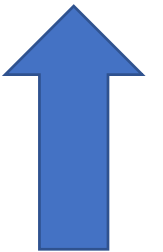
Multifunctional isotope speciality scans
Labeled WBC scans, antibodies, peptides
Image quality is poor, trending down



^{18}F

PET emitter
110 min half life
Cyclotron produced

Multifunctional isotope for PET imaging, ideal energy
FDG scans, PSMA
Image quality is excellent especially with hybrid imaging



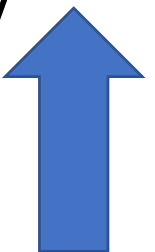
^{68}Ga

PET emitter

68 min half life

^{68}Ge \longrightarrow ^{68}Ga Generator

Up and coming PET isotope. Requires on site generation/chemistry
DOTATATE and PSMA scans
Unclear what will happen in future but currently growing especially
Outside US



^{131}I

Gamma emitter

8d half life

Nuclear Reactor produced

Long term therapy for thyroid cancer

^{123}I - imaging ^{124}I PET imaging, ^{125}I therapy (seeds)

Thyroid cancer treatment is increasing due to increased diagnosis



^{223}Ra

Alpha emitter

11 d half life

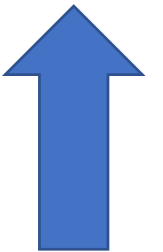
Nuclear Reactor produced

First FDA approved alpha therapy for bone

Targets prostate and breast bone metastases although used widely

Easy to administer

No domestic production (Norway)





Beta emitter

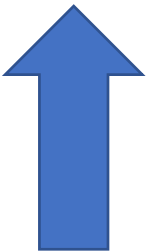
64h half life

Nuclear Reactor produced

Incorporated into resin coated microspheres (Theraspheres™)

Used primarily in liver cancers as part of a radioembolization procedure

Prolongs life, rarely cures patient



^{177}Lu

Beta emitter

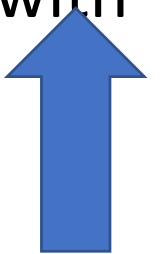
6.7d half life

Nuclear Reactor produced

Popularized in Europe

Initial therapy for Neuroendocrine tumors was highly successful (Lutathera™)

Growing indications for prostate cancers and others based on chelation with
The DOTA chelator



Tier 2 (less commonly used isotopes)

^{201}Tl

gamma emitter

73h half life

Cyclotron produced

Cardiology agent to detect intact cardiac muscle vs. infarct



^{82}Rb

PET emitter

75s half life

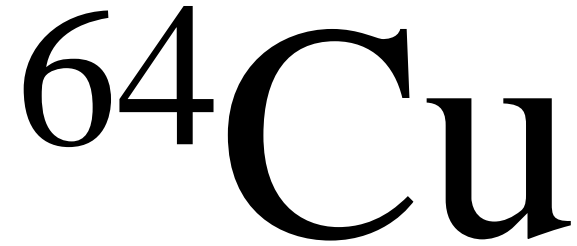
Cyclotron produced

Generator produced

$^{82}\text{Sr} \longrightarrow ^{82}\text{Rb}$

Cardiology agent to detect intact cardiac muscle vs. infarct





PET emitter

12h half life

Reactor/Accelerator produced

Newly approved agent for diagnosis of neuroendocrine tumors

${}^{67}\text{Cu}$ has been suggested as a theranostic isotope

Remains to be seen whether it will be successful

Liver uptake



^{89}Sr

Beta emitter
65d half life
Reactor produced

Formerly used for bone metastases

Also ^{153}Sm (46h beta) and ^{186}Re (90h, Beta,gamma) are used in a similar way

Use is declining in favor of ^{223}Ra



Tier 2 Therapeutic

^{192}Ir

Beta emitter
74d half life

Used for implanting radioactive seeds into tumors
Cervical, prostate etc.



^{103}Pa

Gamma emitter
17 d half life

Used for implanting radioactive seeds into tumors
Cervical, prostate etc.



Tier 3 (Research isotopes)

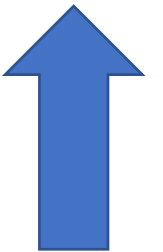
^{89}Zr

PET emitter

78 Hour half life

Cyclotron produced

Long lived PET agent useful for labeling antibodies and cells
Increasing applications with checkpoint inhibitors





Alpha emitter

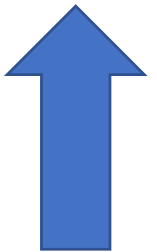
9.9 d half life

Cyclotron produced

Increasing interest in alpha therapies that can be readily chelated

Increasing use outside US (Europe, South Africa, Australia)

^{213}Bi (46min) is similar



^{212}Pb

Alpha emitter

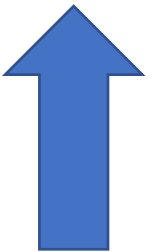
10.6 Hour half life

Generator produced

Increasing interest in alpha therapies that can be readily chelated

Attractive short half life

Gamma emitting isotope ^{203}Pb for diagnostics



^{227}Th

Alpha emitter

18 day half life

Generator produced

Byproduct of ^{223}Ra production means there is excess capacity
Very long half life is disadvantageous for practical reasons



^{47}Sc

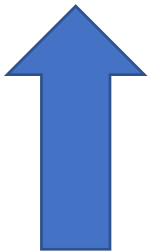
Beta emitter/gamma
3.35 day half life

Similar to ^{177}Lu in chemistry

^{44}Sc (4hr half life) is PET emitter

Increasing research on these isotope but not mainstream

Potential for therapy/imaging theranostic pair



Summary

- Nuclear Medicine is evolving rapidly and new radioisotopes are being employed.
- Targeted radionuclide therapy is becoming more important with Beta and Alpha emitters
- Some traditional agents are in decline as new agents take their place
- Expect continued turmoil in the types of isotopes in demand for nuclear medicine over the coming decade.