Current Status and Future Perspective of Radiopharmaceuticals in Nuclear Medicine

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Prevention, Diagnosis, Treatment

# Radiopharmaceuticals

- Radiopharmaceuticals Drugs that contain radioactive atoms
- Radiopharmaceuticals are used for imaging and therapy
- Diagnostic radiopharmaceuticals have no pharmacological effect
  - Examples:
    - Heart disease (e.g., <sup>99m</sup>Tc, <sup>18</sup>F, <sup>82</sup>Rb)
    - Cancer (e.g., <sup>18</sup>F, <sup>68</sup>Ga)
- Therapeutic radiopharmaceuticals deliver radiation therapy directly to a lesion
  - Examples:
    - Seeds for prostate cancer therapy (<sup>192</sup>Ir)
    - Targeted therapy (<sup>90</sup>Y, <sup>131</sup>I, <sup>223</sup>Ra)
- More than 20 million nuclear medicine procedures are performed each year in the US, ~ 50% of the global market
- Nuclear medicine is ~ \$2 billion USD/year industry
- The health benefits and economic impact are enormous

# How are radioisotopes produced?







### Reactors

## Cyclotrons

## Generators

## Technetium-99m



Epilepsy

 $H_{3}CO + CH_{3} +$ 









Heart Attack



Technescan-MDP®



# How are cyclotron radiopharmaceuticals produced?



## **Before and after Gleevec:** Monitoring Drug Success with F-18 Fludeoxyglucose





#### <sup>18</sup>FDG Avid Tumors in Liver

## [<sup>11</sup>C]PiB Amyloid PET- Klunk and Mathis 2004





[<sup>11</sup>C]PiB

- Derivative of thioflavin T (amyloid binding dye)
- Crosses BBB; high affinity for human amyloid
- <sup>18</sup>F-labeled tracers for amyloid developed because of more convenient 110 min T<sub>1/2</sub>, capability for centralized commercial distribution

# FDA Approvable Facilities... GMP & GLP Programs



# **I-131 Capsules**





Diagnostics	Therapy
1-6 MBq	37-7,400 MBq





# Lu-177 DOTATATE PRRT



- Response to <sup>177</sup>Lu dotatate PRRT in a rectal NET with a massive (21.5cm diameter) inoperable right lobe liver metastasis
- Treatment with <sup>177</sup>Lu dotatate every 8 weeks
- <sup>68</sup>Ga dotatate Images are immediate post initial treatment, and every 8 weeks
- Last image, on right, liver lesion has shrunk to 1.5 cm. (43 GBq cumulative activity)

