Quo Vadis Nuclear Medicine

Threats and Opportunities
from a Manufacturer's Perspective

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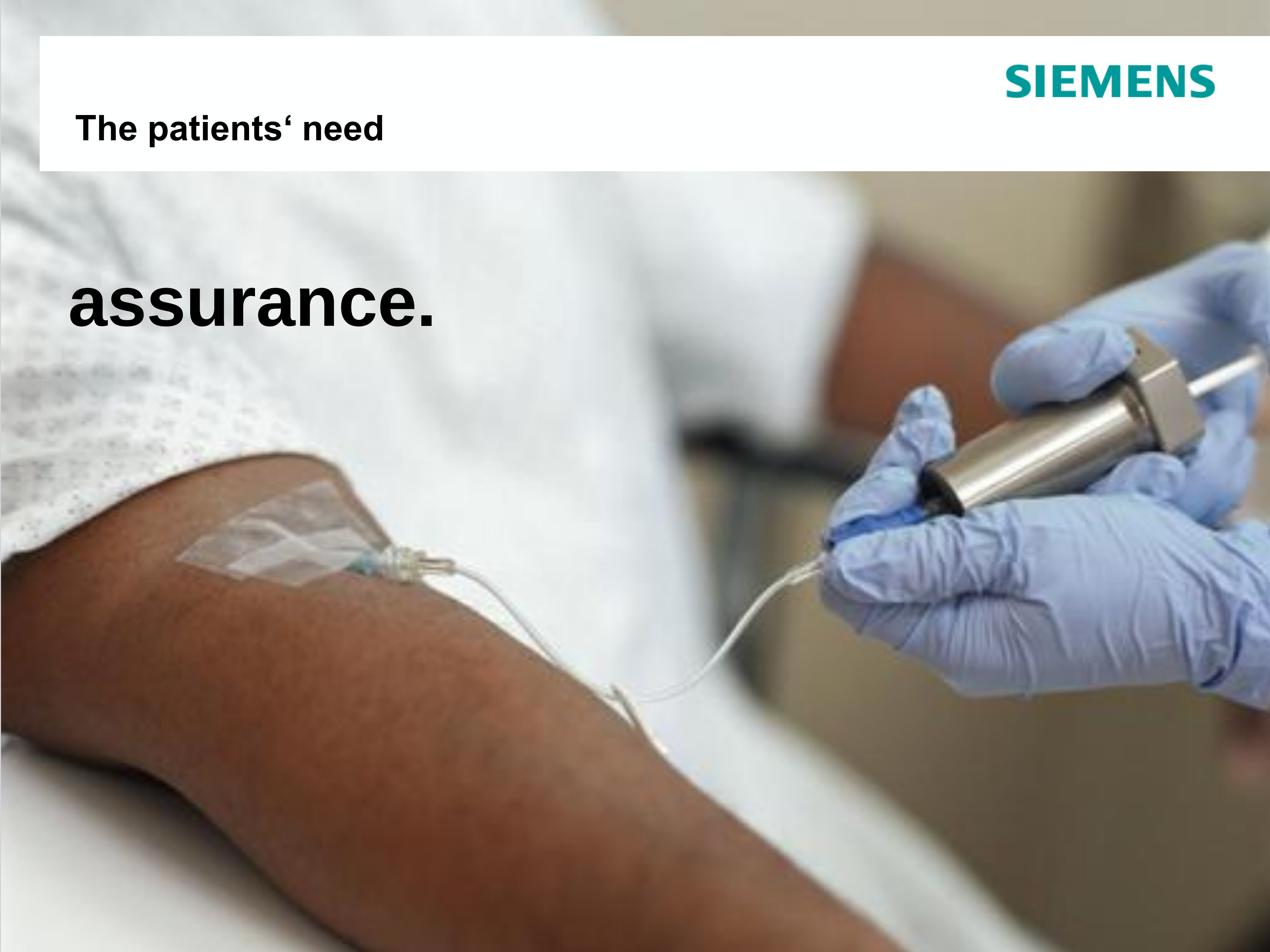
The patients‘ need

assurance.



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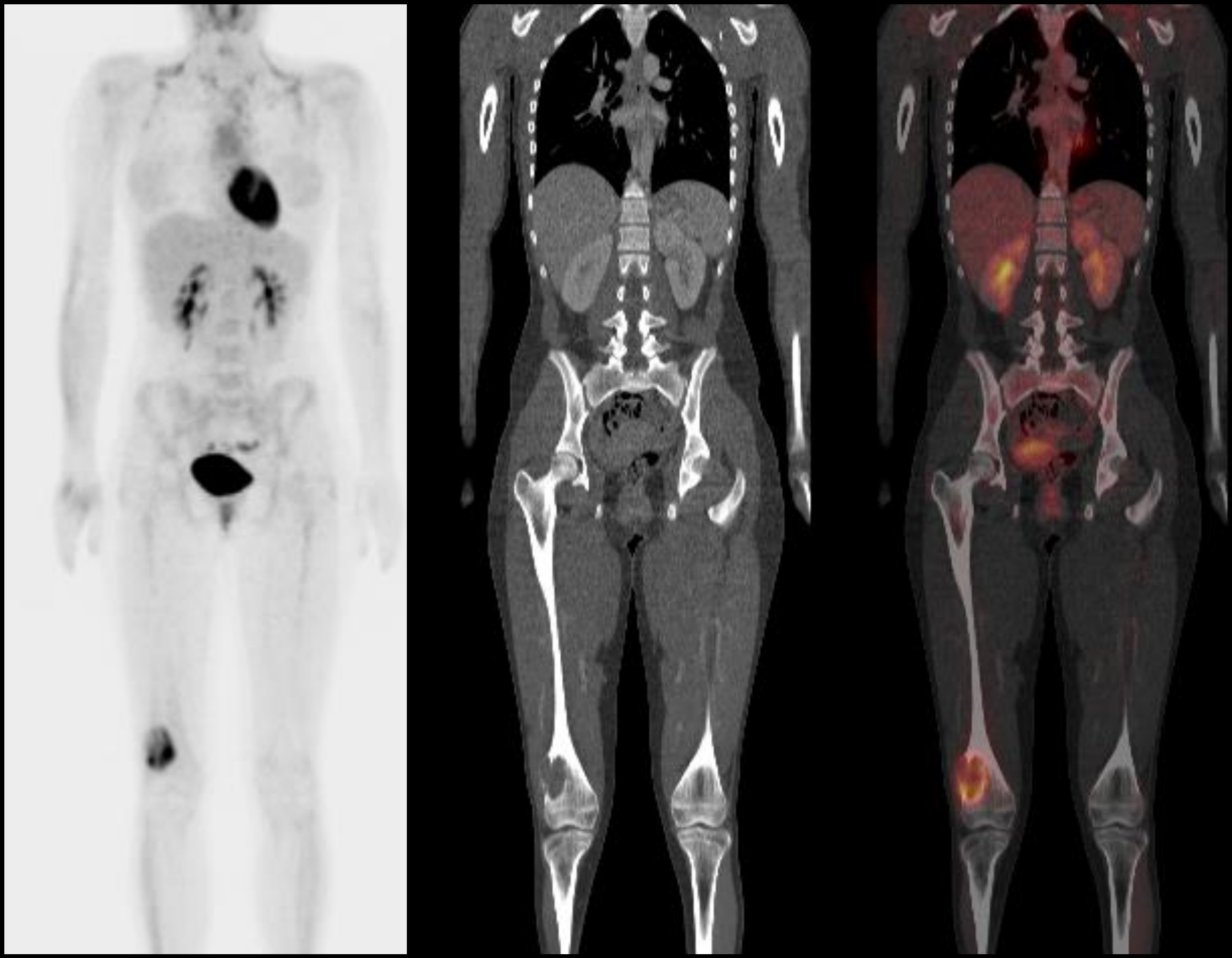
… it can save lives:



i.e. limb salvage instead of amputation with PET CT

(14yr old girl with osteosarcoma of lower end of right femur.)

Data courtesy of B.C. Cancer Research Center, Vancouver/Canada

Use of radioactive isotopes in diagnostic imaging

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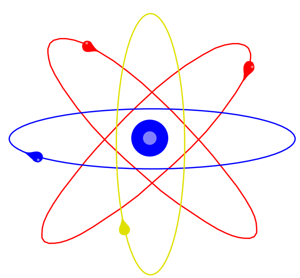
Radio tracer production. Logistics



Radioisotope + Drug

Drug injection Data acquisition

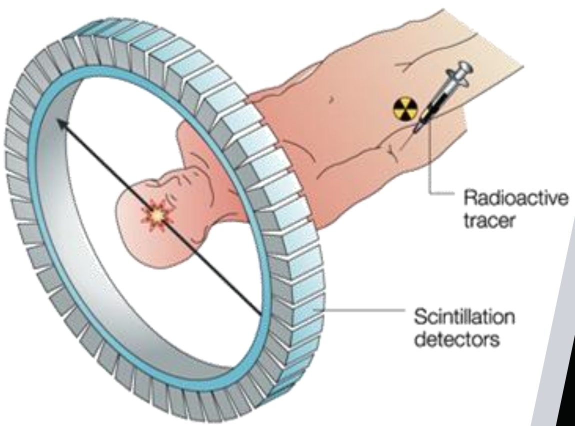
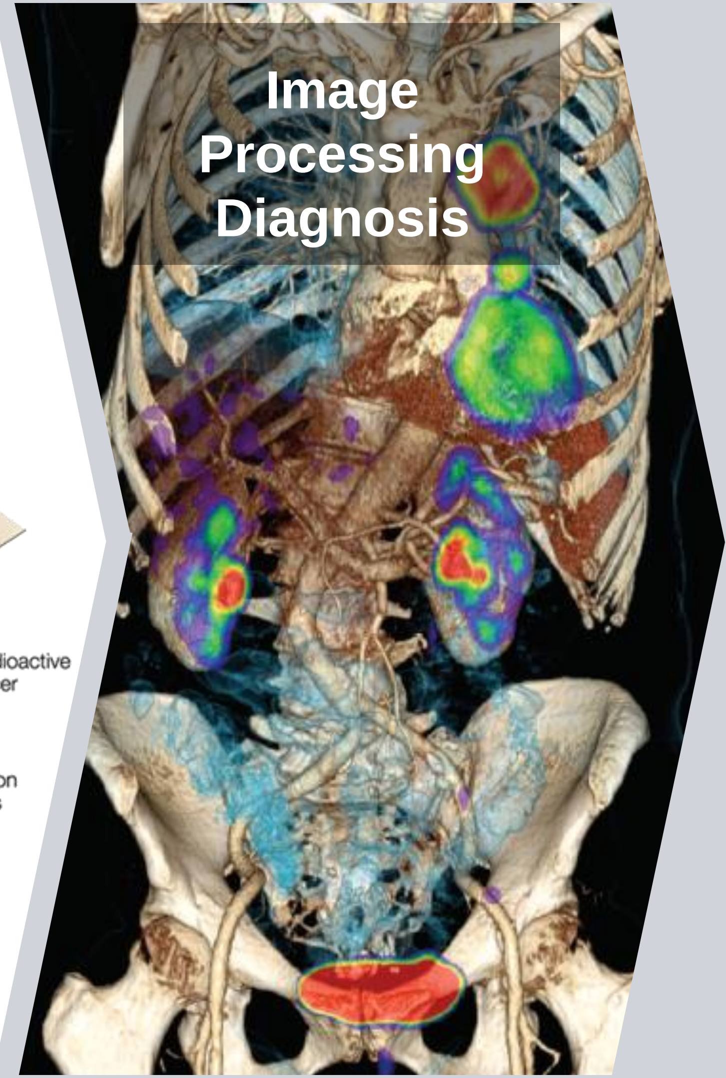


Image Processing Diagnosis



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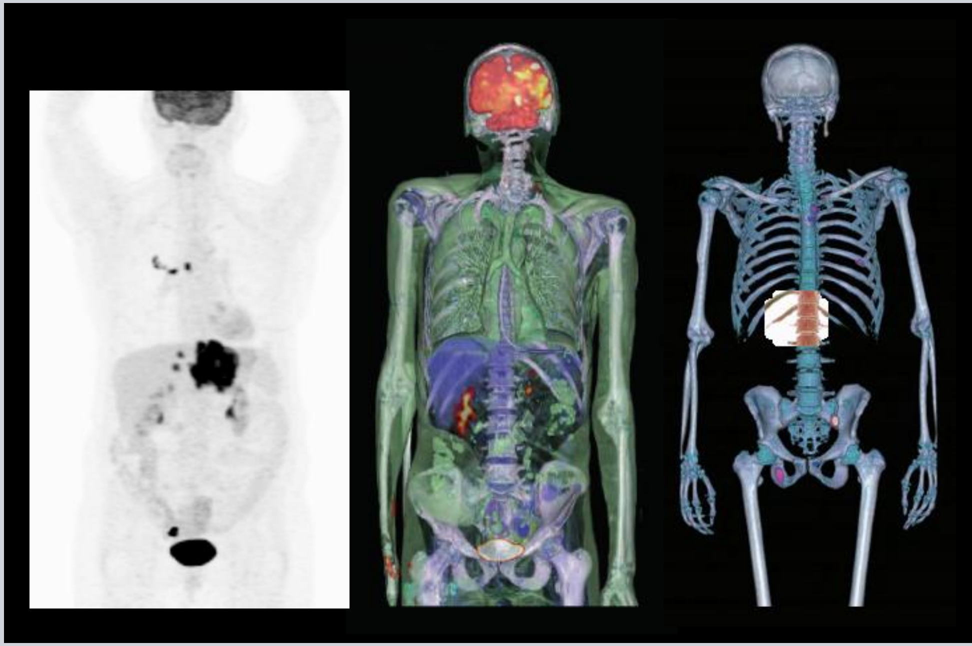
Medical Radio Isotopes

Medical radio isotope applications

- **Scintigraphy**
- Positron Emissions Tomography **PET**
- Single Photon Emission Computed Tomography **SPECT**
- In vitro diagnostics (**RIA**s)

- With > 80% of procedure volume SPECT is the method of choice in nuclear medicine
- Technetium 99m is the most used radio isotope

- PET is comparatively small but rapidly growing market



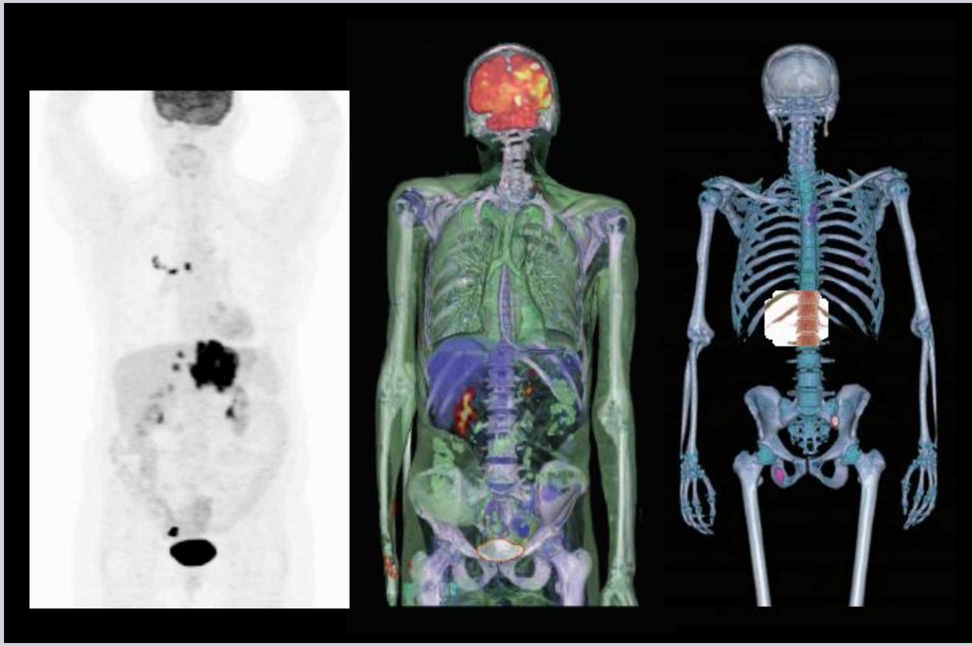
scintigram PET-CT SPECT-CT

Medical Radio Isotopes

Diagnostic indicators

- local isotope concentration over time

- Anatomic information
  tumor localization, volume etc
- Functional information
  perfusion, uptake, excretion etc
- Radio therapy



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Medical applications

Organs	Isotopes	Diseases
Lung	^{99m}Tc, ^{122}Xe, ^{82m}Kr,	Embolisms, breathing disorders
Bone	^{99m}Tc	Tumours, infection, bone fracture
Thyroid	^{131}I, ^{99m}Tc, ^{123}I	Hyper/hypothyroidism, tumours
Kidney	^{99m}Tc, ^{111}In, ^{131}I	Renal function
Brain	^{99m}Tc, ^{123}I, ^{133}Xe	Embolisms, blood flow, tumours, neurological disorders
Liver, pancreas	^{99m}Tc, ^{111}In	Tumours
Abdomen	^{99m}Tc, ^{67}Ga	Tumours
Blood	^{99m}Tc, ^{111}In	Infection, blood volume and circulation
Heart	^{99m}Tc, ^{201}Tl, ^{82}Rb	Myocardial function and viability
All	^{67}Ga, ^{99m}Tc, ^{111}In, ^{201}Tl	Tumours

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^{99m}Technetium – the Swiss army knife

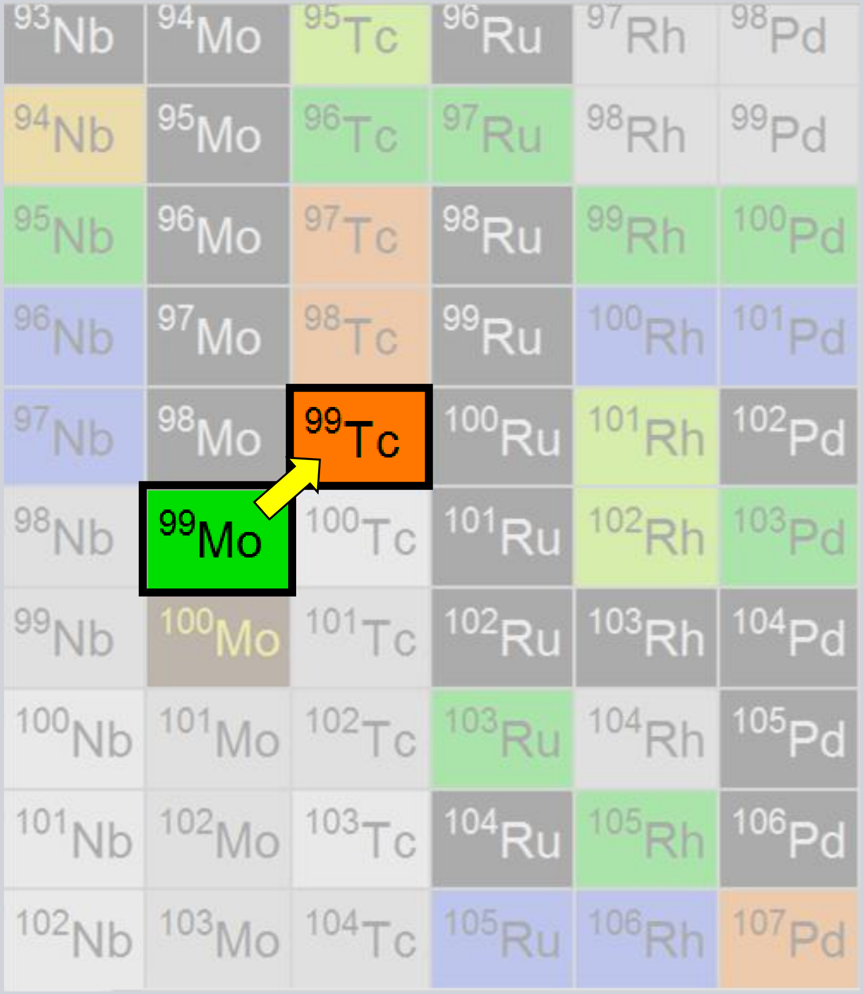
Advantages

- Short half life (6.02 h)
- Pure γ emitter
- Relatively hard gamma rays (141keV)
- Low effective patient radiation dose
- Week-long availability due to ^{99}Mo generator (66 h half life)
- Cheap

Disadvantages

- Environmental issue (^{99}Tc is low β emitter, 211.000 y)
- Drug labeling necessary for disease specificity

Used in > 80 % of all exams



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And what about the rest?

Other radio isotopes

Advantages:
- Drug labeling mostly unnecessary
- Optimal half life, bio distribution, patient dose etc
- Multi isotope exams possible

Disadvantages:
- Lots of rare procedures
- Expensive, uneconomic within the current supply logistics
- Long half life needed if produced remotely and shipped

High pressure to migrate procedures to ^{99m}Tc or **CT, MR, in vitro**

Accelerator products

^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{55}Fe, ^{57}Co, ^{61}Cu, ^{64}Cu, ^{67}Ga, ^{74}As, ^{76}Br, ^{81m}Kr, ^{82m}Rb, ^{94m}Tc, ^{97}Ru, ^{111}In, ^{123}I, ^{124}I, ^{179}Ta, ^{210}Tl

Fission reactor products

^{3}H, ^{14}C, ^{51}Cr, ^{64}Cu, ^{97}Ru, ^{99}Mo, ^{125}I, ^{131}I, ^{133}Xe, ^{153}Gd, ^{195m}Pt

^{99m}Technetium – a horse´s hair

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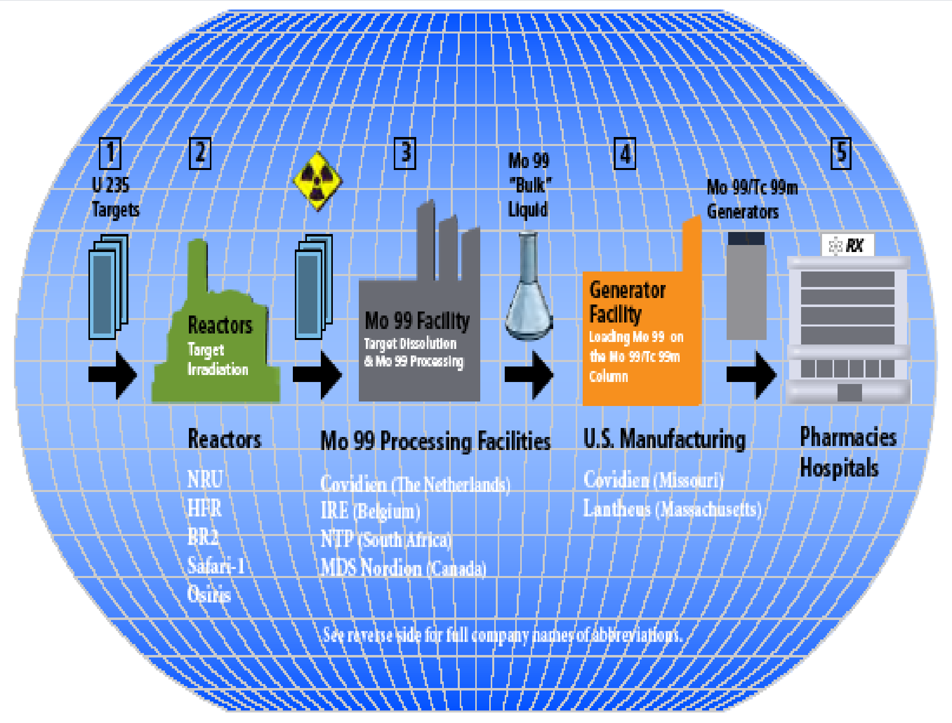
- Very few worldwide production sites
- Operating on highly enriched uranium HEU
- Worldwide timely delivery takes substantial logistical effort
- Global shipment of large amounts of dangerous substances

Fragile supply chain

Shock effect of the supply crisis in ~ 2010



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PET - A special case

- 117min ^{18}F half live enforces local isotope production
- Only partial replacement for SPECT, scintigraphy
- Particle accelerator based isotope production and drug labeling is done within hospitals: “baby cyclotrons”
- Reimbursement schemes make this effort still economic
- Recently US FDA enforces industrial production quality standards
- One answer is distributed but industrialized production facilities

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Quo Vadis Nuclear Medicine ?

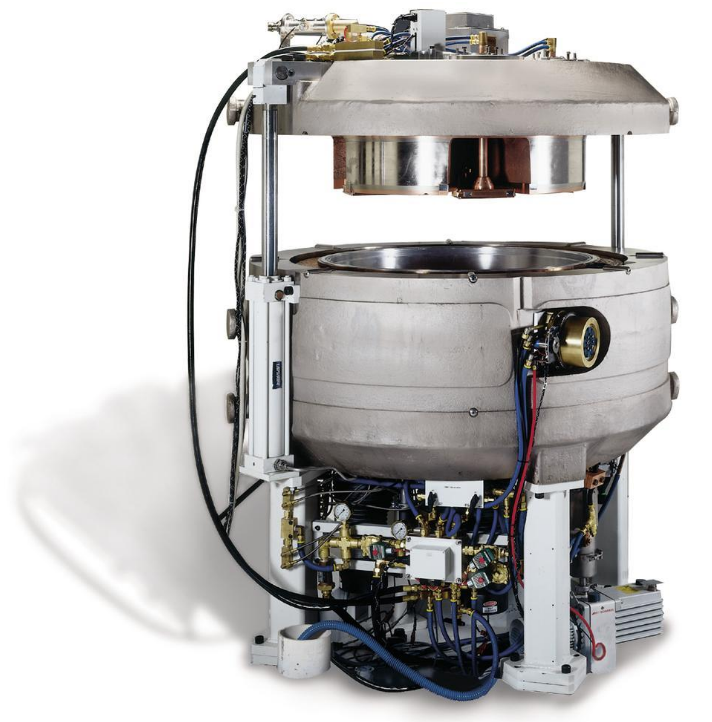
Nuclear Medicine – the ideal

On demand availability of a variety of isotopes

- Minimizes waste
- Minimizes production effort
- Minimizes radiation exposure
- Independence of supply chain problems

Local production means

- Particle accelerator based
- No fission reactor production
- Industrial quality drug processing
- Production automation
- Has to be economically feasible under current reimbursement



Nuclear Medicine – the medical perspective

There is a long time tendency to replace nuclear medicine with radiological exams:

- Lung emboli scans: helical CT angio
- Tumor search: MRI
- Functional studies (kidneys, heart): MRI, CT, ultrasound
- Vitamin B12 deficiency: in vitro test (gastric antibodies)

PET migrates itself towards radiology

- PET-CT hybrid scanners established PET in medicine!

The Big Questions

Is Nuclear Medicine really irreplaceable?

Does PET demonstrate the way forward?

- local production
- integration into radiology

What does this mean for isotope production and delivery?

- particle accelerator design
- industrial distributed production
- supply chain business models

Thank you

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