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Radioisotopes and radiopharmaceuticals for nuclear medicine in Georgia

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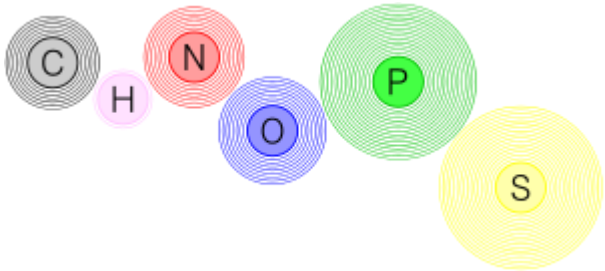
Introduction

Radio-isotopes for nuclear medicine:

- Diagnostic (nuclear / molecular imaging):

  Biologically active elements (H, C, O.), Short life-time, . . .



- Therapy/treatment

  ^{60}Co (radiation therapy), ^{192}Ir – brachytherapy

- Calibration sources:

  ^{57}Co, ^{68}Ge , ^{137}Cs

Physical properties of radionuclides used in nuclear medicine studies

Radionuclide	Decay Mode	Principal Photon Emissions	Half-Life	Primary Use
^{11}C	β^+	511 keV	20.4 min	Imaging
^{13}N	β^+	511 keV	9.97 min	Imaging
^{15}O	β^+	511 keV	2.03 min	Imaging
^{18}F	β^+	511 keV	110 min	Imaging
^{32}P	β^-	—	14.3 d	Therapy
^{67}Ga	EC	93, 185, 300 keV	3.26 d	Imaging
^{82}Rb	β^+	511 keV	1.25 min	Imaging
^{89}Sr	β^-	—	50.5 d	Therapy
^{99m}Tc	IT	140 keV	6.02 hr	Imaging
^{111}In	EC	172, 247 keV	2.83 d	Imaging
^{123}I	EC	159 keV	13.2 hr	Imaging
^{125}I	EC	27–30 keV x rays	60.1 d	In vitro assays
^{131}I	β^-	364 keV	8.04 d	Therapy/ imaging
^{153}Sm	β^-	41, 103 keV	46.7 hr	Therapy
^{186}Re	β^-	137 keV	3.8 d	Therapy
^{201}Tl	EC	68–80 keV x rays	3.04 d	Imaging

EC, electron capture; IT, isomeric transition.

Source:Radionuclide and radiopharmaceutical production

Radioisotope production

Cyclotron
Used to produce radioactive very short lived tracers such as fluorine-18

Nuclear reactor

Neutron-activated radionuclides of importance in biology and medicine

Radionuclide	Decay Mode	Production Reaction	Natural Abundance of Target Isotope (%)*	σ_c(b)†
^{14}C	β^-	$^{14}N(n,p)^{14}C$	99.6	1.81
^{24}Na	(β^-,γ)	$^{23}Na(n,\gamma)^{24}Na$	100	0.53
^{32}P	β^-	$^{31}P(n,\gamma)^{32}P$ $^{32}S(n,p)^{32}P$	100 95.0	0.19 0.1
^{35}S	β^-	$^{35}Cl(n,p)^{35}S$	75.8	0.4
^{42}K	(β^-,γ)	$^{41}K(n,\gamma)^{42}K$	6.7	1.2
^{51}Cr	(EC,γ)	$^{50}Cr(n,\gamma)^{51}Cr$	4.3	17
^{59}Fe	(β^-,γ)	$^{58}Fe(n,\gamma)^{59}Fe$	0.3	1.1
^{75}Se	(EC,γ)	$^{74}Se(n,\gamma)^{75}Se$	0.9	30
^{125}I	(EC,γ)	$^{124}Xe(n,\gamma)^{125}Xe \xrightarrow{EC} {}^{125}I$	0.1	110
^{131}I	(β^-,γ)	$^{130}Te(n,\gamma)^{131}Te \xrightarrow{\beta^-} {}^{131}I$	33.8	0.24

Medical facilities that use radio-isotopes for diagnosis/treatment

Aversi- Center of nuclear medicine.
Radioisotopes:
^{99m}Tc, ^{131}I

Clinical medicine scientific-research institute- Todua
Radioisotopes: ^{99m}Tc, ^{131}I, ^{18}F, ^{192}Ir, ^{68}Ge, ^{57}Co, ^{137}Cs

Radiation medicine center
Radioisotopes: ^{99m}Tc, ^{131}I, ^{60}Co

Radio-isotopes used in Georgia

Isotope	$T_{1/2}$	Eγ(kev)	Nuc. Med.	Production	Clinic
$^{18}F(\beta+)$	109.78 m	511	Imaging	Cyclotron	RMC, HIMC
^{99m}Tc (γ)	6.01 h	140	Imaging	Reactor ($^{99}Mo/^{99m}Tc$ Generator)	Aversi, RMC, RICM
^{131}I (β-)	8.02 d	364	Imaging Treatment	Reactor	Aversi, RMC, RICM
^{60}Co (γ)	5.2714 y	1173	Treatment	Reactor	RMC
^{192}Ir (β^-)	73.8 d	180	Treatment	Accelerator	RMC
^{57}Co	272 d	14.4	For calibration	Cyclotron	RMC
^{68}Ge	270.8 d	106	For calibration	^{76}Ge	RMC
^{137}Cs (β-)	30.08 y	1170	For calibration	Reactor	RMC

[1]RICM – Research Institute of Clinical Medicine (Medical Center of Acad. Todua)
[2]RMC - Radiation Medicine Center

Import of radioisotopes in Georgia

^{131}I

^{68}Ge
"Destek"

^{18}F
Company:
"Monrol"

^{137}Cs
^{57}Co
"Kapindek
"

^{99}Mo
Company:
"Parstek"

SOME RADIONUCLIDE GENERATORS USED IN NUCLEAR MEDICINE

Daughter*	Decay Mode	$T_{1/2}$	Parent	$T_{1/2}$
^{62}Cu	β^+,EC	9.7 min	^{62}Zn	9.3 hr
^{68}Ga	β^+,EC	68 min	^{68}Ge	271 d
^{82}Rb	β^+,EC	1.3 min	^{82}Sr	25 d
^{87m}Sr	IT	2.8 hr	^{87}Y	80 hr
^{99m}Tc	IT	6 hr	^{99}Mo	66 hr
^{113m}In	IT	100 min	^{113}Sn	120 d

*Generator product.

EC, electron capture; IT, isomeric transition.

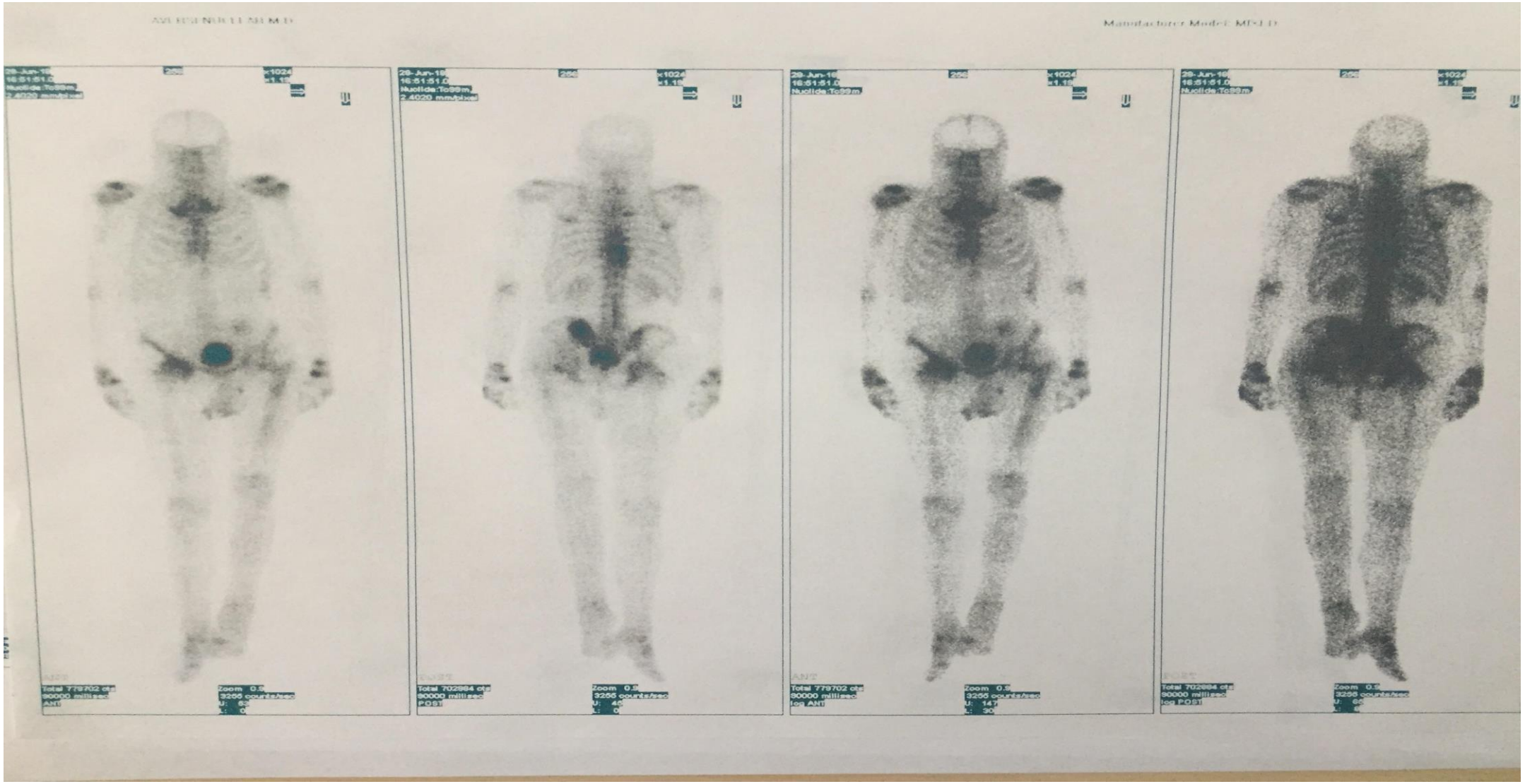
Radio-isotopes also can be produced by generators. For example, isotope ^{99m}Tc is produced from ^{99}Mo, which is imported in Georgia from Iran by company called "Parstek", also from turkish company "Monrol".

Example: Aversi- center of nuclear medicine

Gamma-camera used in Aversi
Used for 2 radioisotopes:
^{99m}Tc, ^{131}I

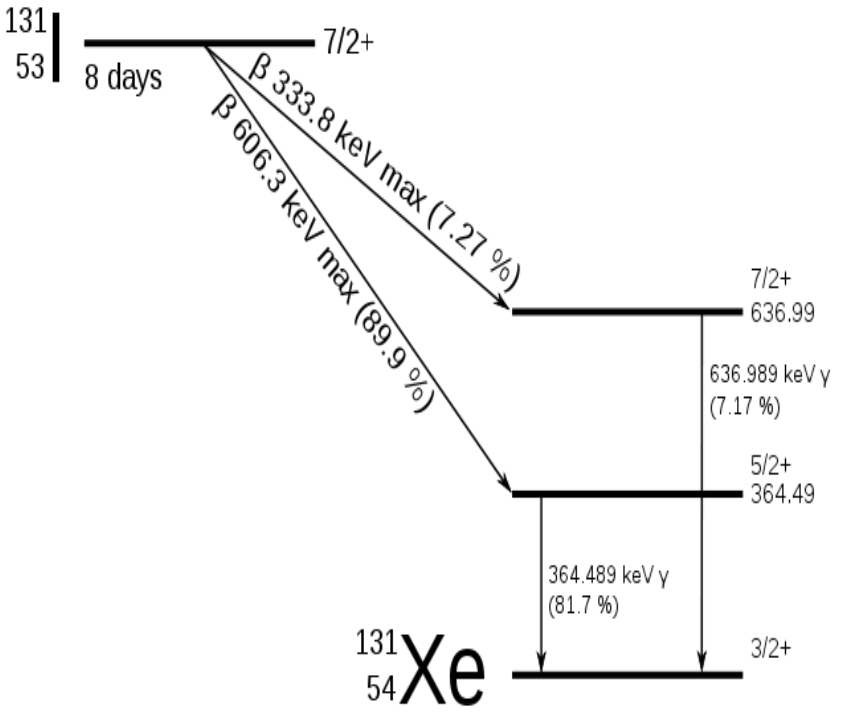
Example from Aversi nuclear medicine center:

Full body scan with ^{99m}Tc (bone scintigraphy)

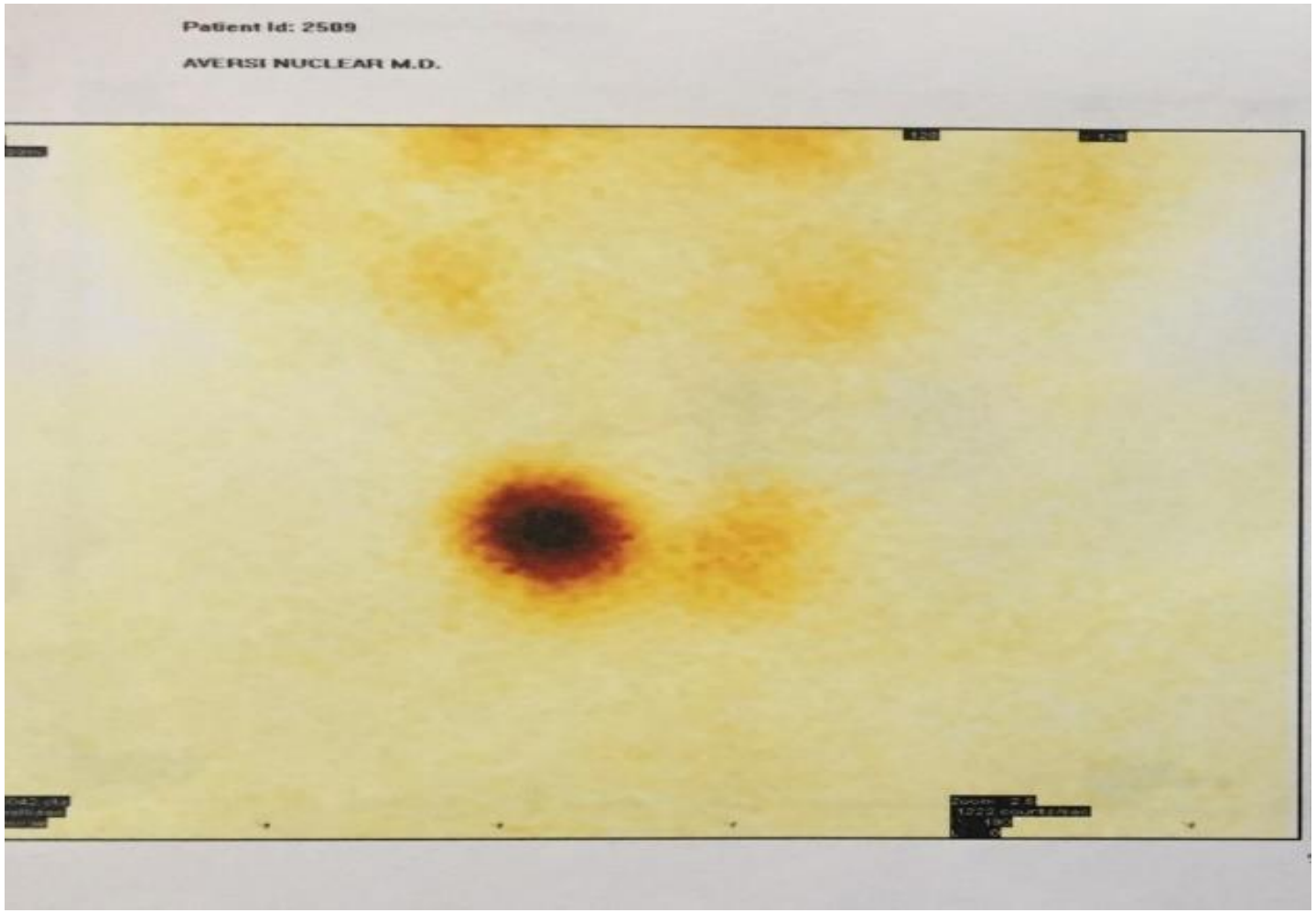


Nuclear medicine treatment

Basically, Radioactive Iodine (^{131}I) is the only isotope used for treatment of thyrotoxicosis.
Therapeutic effect depends on emission of β rays.
Isotope is Imported from Hungary.



Example from Aversi nuclear medicine center:
Thyroid scan with ^{99m}Tc



Summary and Outlook

- Radio-isotopes in Georgia are imported from different countries
- Research nuclear reactor (Mtskheta) – was decommissioned in 1990.
- PET scan require short lived radio-isotope (^{18}F) –
  - ! limiting factor for the PET-technique in Georgia
- Cyclotron for radio-isotope production in Georgia is under consideration

Thank you for attention!