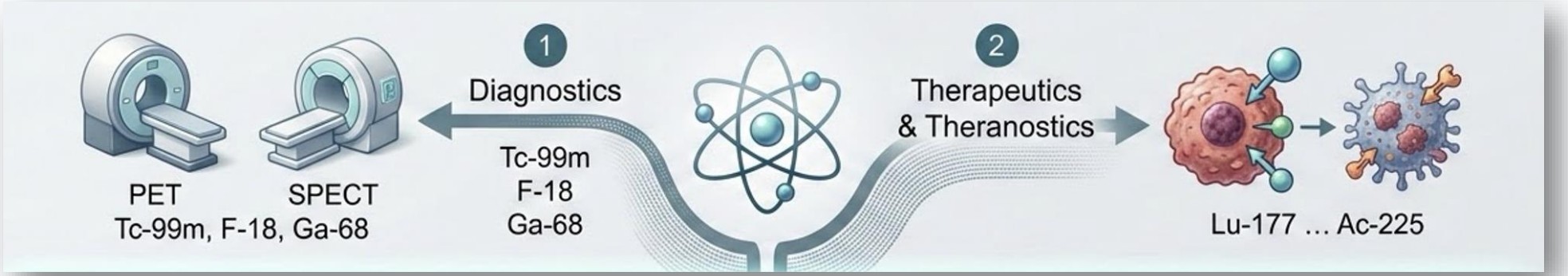
Landscape of Radioisotopes in Medicine

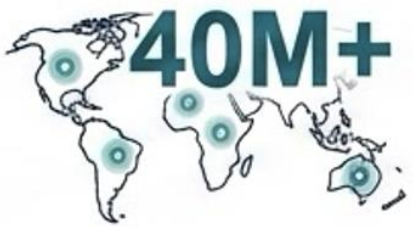
IFIGENEIA Project – Horizon Europe initiative for sustainable radioisotope production



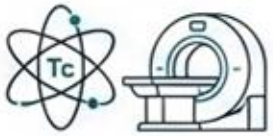
Radioisotopes are not just tools –
they are becoming a foundation of precision medicine.

Nuclear medicine: a global healthcare pillar

More than 40 million nuclear medicine procedures performed annually worldwide.



Essential in oncology, cardiology, neurology and endocrinology.



Around 85% of diagnostic scans still rely on Tc-99m from Mo-99 decay.

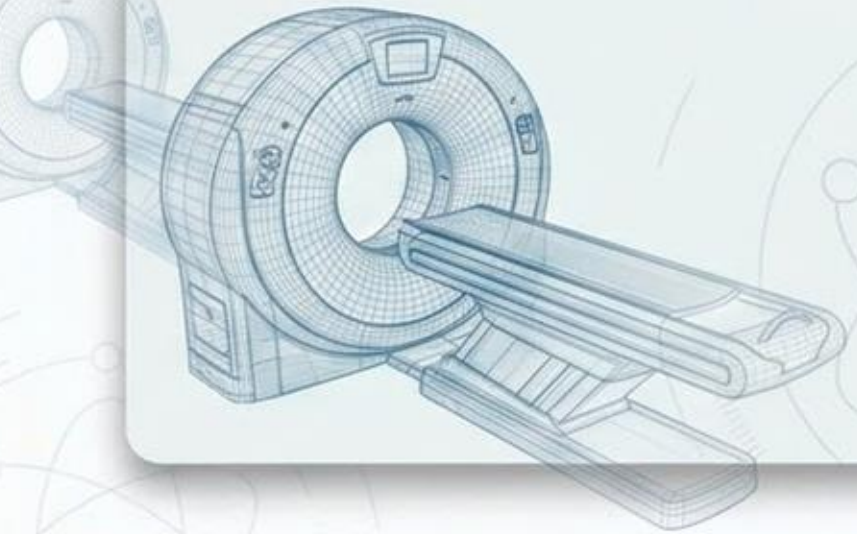
Therapeutic radiopharmaceuticals are rapidly transforming cancer care.

Three pillars of medical radioisotopes

Diagnostics

SPECT and PET for disease detection, staging and response assessment.

Tc-99m, F-18 and Ga-68 are the backbone of routine practice.



Therapeutics and theragnostics

Targeted radionuclide therapy for cancer and selected benign diseases.

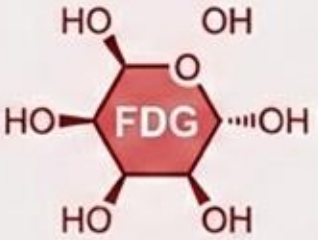
Theranostics: same molecular target, different isotope for imaging and for therapy.

Key diagnostic radioisotopes

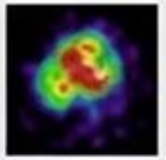
Tc-99m, (t½ ~6 h)

myocardial perfusion, bone scans, renal and many other indications.

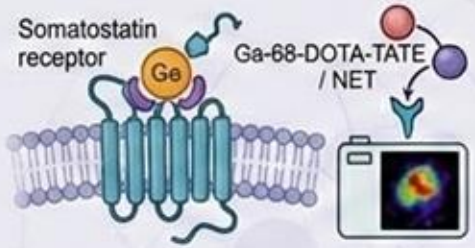
F-18, (t½ ~110 min)



FDG-PET in oncology and neurology, plus disease-specific tracers.



Ga-68, t½ ~68 min)



PSMA-PET and somatostatin receptor imaging in neuroendocrine tumors.

F-18-PSMA

prostate cancer imaging with extended logistics and regional distribution.

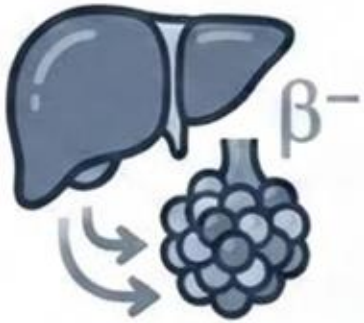
Therapeutic radioisotopes: an evolving arsenal

I-131 (β–, t½ ~8 d): gold standard for differentiated thyroid and hyperthyroidism.

FDA/ EMA

Lu-177 (β–, t½ ~6.7 d): NETs and prostate cancer, PSMA-617 approved by regulators.

Ra-223 (α, t½ ~11.4 d): bone metastases in metastatic castration-resistant prostate cancer.



Y-90 (β–, t½ ~64 h): radioembolization, radiosynoviorthesis, selected lymphoma indications.

The theranostic revolution

Concept

Same molecular target, different radioiosotope for imaging and therapy.

Integrates patient selection, dosimetry, treatment and follow-up.

Same molecular target, different radioisotope for imaging and therapy.

Examples

PSMA theranostics:

Ga-68/F-18-PSMA-PET image,

Lu-177-PSMA-617 therapy.

SSTR theranostics:

Ga-68-DOTATATE-PET image,

Lu-177-DOTATATE therapy.

Clinical impact: PSMA theranostics in mCRPC

Evidence & Approvals

VISION trial: Lu-177-PSMA-617 + standard of care improved OS and rPFS vs. standard of care alone.

Regulatory approval (FDA/EMA) for PSMA-positive mCRPC after ARPI and taxane.

Patient Selection & Response

PSMA-PET is essential for patient selection, identifying PSMA-expressing disease.

Meaningful PSA response rates with a manageable safety profile.

Emerging radioisotopes: next frontier

Ac-225 Alpha therapy

Ac-225 (α, t½ ~10 d): high-LET alpha therapy for resistant tumors.

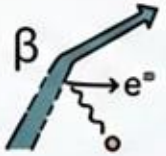
Cu-67 Theranostic partner

Cu-67 (β−, t½ ~62 h): theranostic partner with Cu-64 imaging.

At-211 Alpha-emitter

At-211 (α, t½ ~7.2 h): promising alpha-emitter for targeted applications.

Tb-161 Beta / Auger electrons



Tb-161 (β−, t½ ~6.9 d): beta emissions and Auger electrons, theranostic with Tb-155.

Three clinical examples to keep in mind

Differentiated thyroid cancer: radioiodine as a complete diagnostic–therapeutic pathway.

Lymphoma: 18F-FDG PET/CT guiding staging and response-adapted therapy.

Prostate cancer: PSMA imaging and therapy defining new management strategies.

DIFFERENTIATED THYROID CANCER

radioiodine as a complete diagnostic–diagnostic–therapeutic pathway.

LYMPHOMA

18F-FDG PET/CT guiding staging and response-adapted therapy.

PROSTATE CANCER

PSMA imaging and therapy defining new management strategies.

The global supply crisis

Aging Reactor Dependence & Isotope Shortages.

Europe depends heavily on aging research reactors (HFR, BR2, MARIA, FRM II).

Chronic Mo-99 / Tc-99m shortages disrupt cardiac and oncology imaging.

Production Gaps & Distribution Constraints.

Ac-225 demand vastly exceeds current global supply (mg-scale production).

Cyclotron capacity constraints limit F-18, Ga-68 and Cu-64/67 availability.

Critical bottlenecks limiting clinical translation

Physics & Logistics

Short half-lives demand rapid, reliable distribution chains.

Production capacity has long lead times (3–5 years for new facilities).

Complex coordination of production, QC, transport and administration.

Clinical and economic impact

Shortages delay imaging and therapies, affecting patient pathways.

Limited supply drives up costs and reduces access, especially in smaller countries.

Innovation reaches patients slowly when supply is fragile.

A view from Greece and South-Eastern Europe

Peripheral Geography & Logistics

Peripheral geography and cross-border logistics amplify global supply problems.

Transport Delays as Clinical Problems

Short half-lives mean that transport delays quickly become clinical problems.

Small-Market Disruptions

Smaller-market settings feel disruptions faster, in both diagnostics and therapy.

Isotope Access as as Quality Care

For clinicians, isotope access is part of quality of care, not a secondary technical issue.

LINAC technology: a sustainable alternative

Why LINAC?

Tunable, flexible, potentially lower environmental impact.

Can be optimized for selected medical radioisotopes.

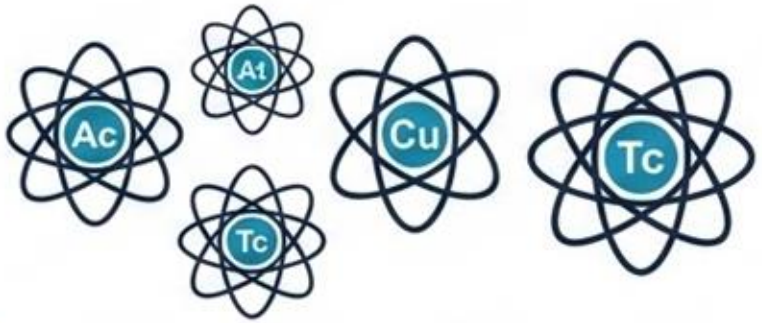
Offers diversified production routes beyond classical reactor dependence.

Target isotopes

Prospects for Ac-225, At-211, Cu-67 and others in suitable configurations.

Exploration of Tc-99m via alternative Mo-99 production approaches.

Supports the overall goal of more resilient medical isotope supply.



IFIGENEIA: building a regional ecosystem

Excellence hubs in Greece, Slovenia and Cyprus connecting production, R&D and clinical use.

LINAC facility design aimed at marketable and clinically relevant radioisotopes.

Cross-border collaboration, training and innovation in nuclear medicine.

Toward greater European independence in critical medical isotope supply.

CONNECTING PRODUCTION & R&D

Excellence hubs in Greece, Slovenia and Cyprus connecting production, R&D and clinical use.

MARKETABLE ISOTOPE DESIGN

LINAC facility design aimed at marketable and clinically relevant radioisotopes.

CROSS-BORDER COLLABORATION

Cross-border collaboration, training and innovation in innovation in nuclear medicine.

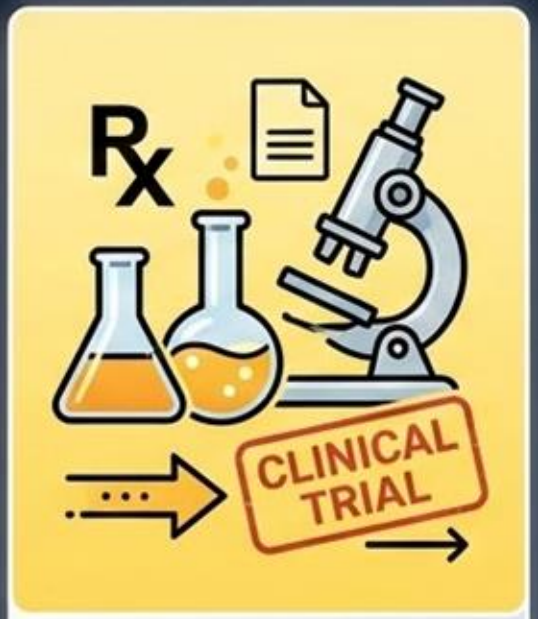
EUROPEAN INDEPENDENCE

Toward greater European independence in critical medical isotope supply.

Strategic impact for Europe and the Balkans

REDUCE DEPENDENCE

Reduce dependence on aging reactor infrastructure and external imports.



ACCELERATE CLINICAL RESEARCH

Faster access to innovative therapies.

CULTIVATE REGIONAL EXPERTISE

Foster expertise in radiochemistry, dosimetry and regulatory science.

GLOBAL INNOVATION HUB

Position the Balkans as an innovation hub for sustainable isotope production.

What clinicians need from future isotope platforms

RELEVANT PORTFOLIO

A clinically relevant portfolio, aligned with real diagnostic and therapeutic demand.

PREDICTABLE QUALITY

Predictable quality, GMP-compatible workflows and robust radiopharmaceutical translation.

TRIALS & DOSIMETRY

Support for multicenter trials, dosimetry protocols and translational research.

TRAINING PATHWAYS

Training pathways for physicians, physicists, radiopharmacists and technologists.

Take-home messages

DIAGNOSTIC & THERAPEUTIC PATHWAYS

Radioisotopes already underpin essential diagnostic and therapeutic pathways.

THERANOSTIC REVOLUTION

Theranostics is changing nuclear medicine from imaging support to treatment definition.

GLOBAL SUPPLY CRISIS

Progress is constrained by fragile supply, aging infrastructure and unequal access.

SUSTAINABLE ECOSYSTEMS (IFIGENEIA)

Sustainable, diversified production and ecosystems like IFIGENEIA are key to unlocking future potential.

Thank you

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Landscape of Radioisotopes in Medicine

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