# FAPI, Where do we stand? Wetenschappelijke vergadering van de NVNG

De wetenschappelijke voorjaarsbijeenkomst van de NVNG werd op 21 juni 2024 in het Anatomiegebouw te Utrecht gehouden met als thema 'FAPI, where do we stand?'. Na de welkomstwoorden van de voorzitter van de Commissie Wetenschappelijke Ontmoetingen (CWO) drs. Emilia Owers startte de eerste ochtendsessie 'FAPI introduction' van het door de CWO samengestelde programma onder voorzitterschap van drs. Tineke van de Weijer en dr. Yann Seimbille met een presentatie van nucleair radioloog en voorzitter van de werkgroep FAPI dr. Andor van den Hoven (St. Antonius Nieuwegein) over 'Introduction and general use of FAPI'. Vervolgens behandelde onderzoeker dr. Hanyue Ma (Erasmus MC) het onderwerp 'Development & preclinical evaluation of FAPI radiopharmaceuticals'. Tenslotte heeft het duo nucleair radioloog dr. Thiemo van Nijnatten en klinisch radiochemicus dr. Matthias Bauwens van het MUCM+ 'METC approval for FAPI; example of breast cancer imaging' gepresenteerd.

Na de pauze startte de tweede ochtendsessie 'Broad spectrum of the use of FAPI' onder voorzitterschap van dr. Hendrikus Boersma en drs. Christel Brouwer met een presentatie van onderzoeker drs. Bram van Leer (UMCG) betreffende 'FAPI in fibrosis after COVID'. Vervolgens behandelden onderzoekers dr. Myrna van den Bos en dr. Maurice van Duijvenvoorde van het UMC Utrecht in een gezamenlijke presentatie het onderwerp 'Theranostics FAPI & Clinical cases'. De sessie werd afgesloten met de 'Fellowship certificate presentation' door nucleair


*Overzicht van het auditorium van het Anatomiegebouw tijdens de eerste sessie van de ochtend.*

*Sprekers van eerste ochtendsessie met van links naar rechts Matthias Bauwens, Thieme van Nijnatten, Hanyue Ma en Andor van den Hoven.*

*Sprekers van de tweede ochtendsessie met van links naar rechts Bram van Leer, Myrna van den Bos en Maurice van Duijvenvoorde.*


*Quido de Lussanet de la Sabloniere (links) van het ErasmusMC krijgt het fellowship certificaat uitgereikt door Arthur Braat (midden) na enkele lovende woorden door Erik Vegt (rechts).*

geneeskundige dr. Arthur Braat (UMC Utrecht), voorzitter van de fellowship commissie.

Na een algemene ledenvergadering van de NVNG en de lunchpauze werd in de middag een sessie gehouden onder voorzitterschap van dr. Erik Aarntzen en drs. Emilia Owers met een vijftal korte presentaties. Onderzoeker drs. Mara Veenstra (Erasmus MC) presenteerde 'Intra-arterial PSMA injection using hepatic arterial infusion pump in intrahepatic cholangiocarcinoma, a proof-of-concept study'. Vervolgens presenteerde klinisch fysicus dr. Roel Wierts (MUMC+) 'Development of dose rate conversion coefficients to assess eye lens and cornea radiation dose in ocular contaminations with radionuclides: eye radiation exposure in incidents revisited' gevolgd door Jessie Rijntjes (Rijnstate) met het onderwerp 'Quantitative single-photon emission computed tomography for dose calculation of radioiodine therapy in hyperthyroidism'. De laatste twee presentaties van deze sessie betroffen 'FAPI voor CUP study' door onderzoeker Esther Droogers (Erasmus MC) en 'PLASTIC-3 study (multicenter stadiëring maagcarcinoom)' door onderzoeker Lianne Triemstra (LUMC).
De samenvattingen van een drietal vrije inzendingen zijn te lezen aan het eind van dit verslag.

Na de pauze werd de laatste sessie ('FAPI and oncology') van het voorjaarssymposium gehouden onder voorzitterschap van dr. Andor van den Hoven en dr. Maurits Wondergem met als gastsprekers nucleair geneeskundige dr. Phillipp Backhaus (Universitätsklinikum Munster) met het onderwerp 'FAPI-PET in breast cancer – why and how', en nucleair geneeskundige / radiotherapeut oncoloog dr. Wouter Vogel (AVL) met de presentatie 'Pilot study of FAPI PET/CT for locoregional (re)staging of

lymph nodes in colorectal carcinoma (FAPI CRC-1)'. De laatste spreker van het symposium was chirurg prof. dr. Onno Kranenburg (UMC Utrecht) met 'FAPI-PET in metastatic colorectal cancer (FOCUS and TROMPET study)'.

*Sprekers van de eerste middagsessie met van links naar rechts Lianne Triemstra, Roel Wierts, Esther Droogers en Mara Veenstra (Jessie Rijntjes niet op foto).*

*Sprekers van de slotsessie van het symposium met van links naar rechts Wouter Vogel, Onno Kranenburg en Philipp Backhaus.*

## Samenvattingen vrije inzendingen middagprogramma

### Intra-arterial PSMA injection using hepatic arterial infusion pump in intrahepatic cholangiocarcinoma, a proof-of-concept study

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#### Rationale

Prostate specific membrane antigen (PSMA) targeted tracers show increased uptake in several malignancies, indicating a potential for peptide radioligand therapy. Intra-arterial injection of radiotracers could increase the therapeutic window. This study aimed to evaluate the feasibility of intra-arterial injection of [$^{68}$Ga]Ga-PSMA-11 for intrahepatic cholangiocarcinoma (ICC) and compare tracer uptake after intrahepatic arterial injection and intravenous injection.

#### Materials and Methods

Patients with pathologically proven inoperable ICC received [$^{68}$Ga]Ga-PSMA-11 (1.5 MBq/kg body weight) through a hepatic arterial infusion pump, followed by PET/CT. Some days later, patients underwent PET/CT after intravenous [$^{68}$Ga]Ga-PSMA-11 injection using the same protocols.

#### Results

Three patients were included. All tumours showed higher uptake on the intra-arterial scan compared with the intravenous scan (intra-arterial / intravenous standardized uptake value normalized by lean body mass (SUL)

ratios 1.40 - 1.54). Uptake in normal liver tissues was similar between intra-arterial and intravenous scans (SUL ratios 0.86 - 1.13). Additionally, [$^{68}$Ga]Ga-PSMA-11 PET/CT showed diffusely increased uptake in large parts of the liver in one patient that seemed more extensive compared with the recent contrast enhanced CT. CT three months post-PET/CT showed tumour progression in these exact segments.

## Conclusions

Local intra-arterial PSMA injection is feasible in patients with ICC. The increased therapeutic window of intra-arterial injection compared with intravenous injection could be an interesting incentive to explore the possibility of PSMA-targeted peptide radioligand therapy for a subset of ICC patients.

# Development of dose rate conversion coefficients to assess eye lens and cornea radiation dose in ocular contaminations with radionuclides: eye radiation exposure in incidents revisited

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## Background

In 2022 a supposedly tenfold exceeding of the annual dose limit of the eye-lens, following an ocular contamination incident, was reported by the Netherlands Labour Authority. However, as dose rate conversion coefficients (DCCs) for ocular contaminations were not available at that time, an incorrect skin contamination model was used which resulted in a hundred fold overestimation of the eye-lens exposure. Consequently, in reality, the eye-lens radiation dose was well within annual dose limits, illustrating the importance of using appropriate dosimetry models. Therefore, the aim of this study was to determine accurate eye-lens and cornea DCCs for ocular contamination for 37 radionuclides used in nuclear medicine (1).

## Methods

For all 37 radionuclides DCCs were determined using two different methods. The first method conducted Monte Carlo (MC) simulations of a simplified setup to determine the absorbed dose at a depth of 3 mm in ICRU tissue. The accuracy of these simulations was validated by experimental thermoluminescent dosimeter (TLD) measurements for F-18, Ga-68, Tc-99m, and Lu-177. In the second method, DCCs were calculated for the complete and radiosensitive part of the eye-lens and the cornea using MC simulations on realistic computational mesh phantoms (2).

## Results

TLD measurements showed excellent agreement (deviations: -5.9, -1.4, 3.0, and -2.4% for F-18, Ga-68, Tc-99m, and Lu-177, respectively) compared to the MC ICRU tissue simulations. Compared to the realistic mesh phantoms, the ICRU model resulted in larger DCCs by a factor of 2-4. For the 37 radionuclides, the mesh phantoms DCCs of the complete eye-lens showed a wide range from $3.08{\cdot}10^{7}$ - $2.38{\cdot}10^{-2}$ mGy·MBq$^{-1}$·s$^{-1}$. Smallest DCCs were observed for radionuclides emitting no or low-energy beta radiation (e.g. Er-169) which do not penetrate to the depth of the eye-lens. Radionuclides emitting high-energy beta radiation (e.g. Y-90, Re-188) showed high DCCs. Overall, DCCs for the radiosensitive part of the eye-lens were larger (up to a factor of 2.5) compared to the complete eye-lens. DCCs for the cornea were larger than those of the eye-lens depending on the emitted radiation type.

## Conclusion

DCCs were developed using realistic computational mesh phantoms for the complete and radiosensitive part of the eye lens and for the cornea for all radionuclides currently used in nuclear medicine applications. The DCCs generated in this study can be highly valuable in radiation safety risk assessments and dose calculations in ocular contaminations with radionuclides and shed a new light on ocular radiation exposure of previously reported incidents.

## References

1. Hoeijmakers, E., et al. Dose rate conversion coefficients for ocular contamination in nuclear medicine: A Monte Carlo simulation with experimental validation. Med Phys. 2024, doi: 10.1002/mp.17073
2. Kim, C. H., et al. ICRP publication 145: adult mesh-type reference computational phantoms. Ann. ICRP. 2020;49(3): 13-201

# Quantitative single-photon emission computed tomography for dose calculation of radioiodine therapy in hyperthyroidism

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## Introduction

Treatment of hyperthyroidism with radioiodine ($^{131}$I) therapy in Graves' disease (GD) and toxic multinodular goiter (TMNG) preferably avoids early hypothyroidism and still effectively cures hyperthyroidism. Currently, patient-specific $^{131}$I dose is calculated based on the iodine uptake ($^{123}$I or $^{131}$I) and thyroid volume measured in planar scintigraphy (PS). However, especially planar volume measurements lack accuracy and have large inter and intra observer variation. $^{131}$I dose calculation using quantitative SPECT/CT may be more accurate and potentially improve clinical outcome. This study aims to determine the accuracy of quantitative SPECT/CT for volume and uptake measurements and compares the $^{131}$I dose for radioiodine therapy as calculated based on PS and quantitative SPECT/CT. Furthermore, the administered $^{131}$I dose concentration is correlated to clinical outcome.

## Methods

Quantitative SPECT/CT was validated in a phantom study. For patients with GD or TMNG, planar $^{123}$I uptake and volume measurements were retrospectively compared to $^{123}$I quantitative SPECT/CT. Furthermore, the administered $^{131}$I dose concentration (MBq/ml) was determined using quantitative SPECT/CT and was correlated to the thyroid function one year after therapy.

## Results

In patients with GD (n=31), the uptake in quantitative SPECT/CT was 65% (IQR 53-78) vs. 52% (IQR 44-60) in PS (p<0.001). The thyroid volume was 22 mL (IQR 17-31) vs. 26 mL (IQR 21-42), respectively (p<0.001). Subsequently, when quantitative SPECT/CT was used to calculate the required $^{131}$I dose, this would have reduced the dose by 38% (p<0.001) (figure 1). One year after therapy, 29% of patients developed euthyroidism, 29% had persistent hyperthyroidism and 42% developed hypothyroidism. Corresponding dose concentrations were 5.6 MBq/mL (IQR 4.4-8.2), 6.1 MBq/mL (IQR 4.4-8.1) and 7.8 MBq/mL (IQR 6.1-9.1) *(nonsignificant (ns.))*.

In patients with TMNG (n=34), the uptake in quantitative SPECT/CT was 37% (IQR 31-48) vs. 26% (IQR 20-37) in PS (p<0.001). The thyroid volume was 38 mL (IQR 26-74) vs. 42 mL (IQR 26-79), respectively (*ns.*). Subsequently, when quantitative SPECT/CT was used to calculate the required $^{131}$I dose, this would have reduced the dose by 23% (*ns.*) (figure 1). One year after therapy, 59% of patients developed euthyroidism, 12% had persistent hyperthyroidism and 29% developed hypothyroidism. Corresponding dose concentrations were 8.3 MBq/mL (IQR 5.6-9.8), 6.7 MBq/mL (IQR 4.0-9.3), and 10.4 MBq/mL (IQR 10.2-11.7) (p<0.05).

## Conclusion

Quantitative SPECT/CT allows for more accurate $^{131}$I dose calculations based on both more accurate thyroid volume and $^{123}$I uptake measurements, compared to PS. Quantitative SPECT/CT might improve clinical outcome after radioiodine therapy in patients with GD or TMNG. ♦

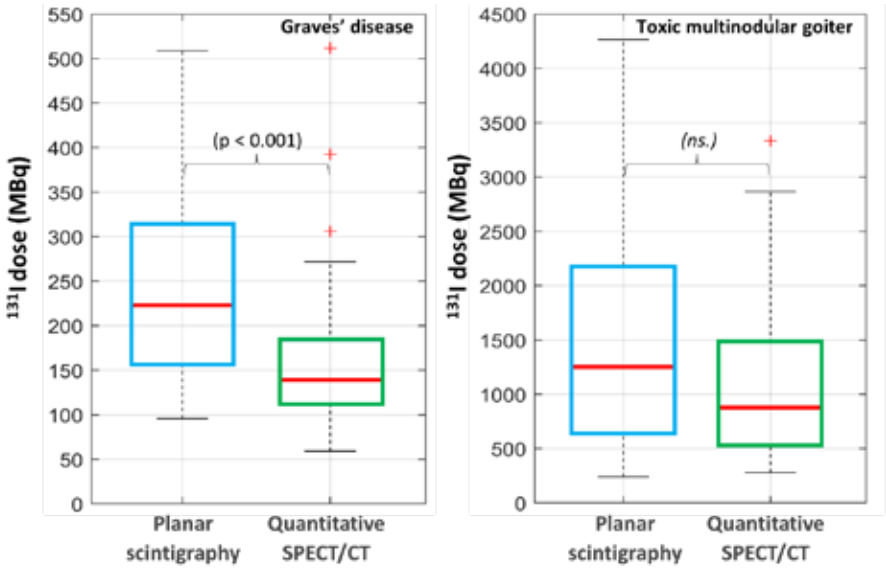


*Figure 1.* The $^{131}$I dose for radioiodine therapy based on $^{123}$I planar scintigraphy (blue) and $^{123}$I quantitative SPECT/CT (green) calculated for treatment of patients with Graves' disease (left) and toxic multinodular goiter (right). For patients with Graves' disease there was a significant difference in $^{131}$I dose (p<0.001). For patients with toxic multinodular goiter, the difference in $^{131}$I dose was nonsignificant.