20. DSMF Symposium

Middelfart 23. – 24. april 2024

Velkommen til 20. DSMF symposium!

Kære deltager.
Dansk Selskab for Medicinsk Fysik byder hjertelig velkommen til dette års symposium på Milling Hotel Park.
Vi har tilrettelagt et spændende videnskabeligt program med indlæg fra såvel nationale som internationale foredragsholdere. Vi håber, at I finder indholdet interessant og underholdende og at vi sammen får et par udbytterige dage på tværs af specialer.

Ud over det videnskabelige program har vi, som tidligere år såvel posterudstilling som firmaudstilling – begge dele vil der være rig mulighed for at kigge på under symposiet. Husk i den forbindelse at deltage i firmaquizzen onsdag, der er en god præmie på spil! Tirsdag afsløres det, hvem der løber med Ung Fysiker pris 2024.
Rigtig god fornøjelse!

DSMF´s Symposieudvalg
Christine Voetmann
Jens Edmund
Jesper Thygesen
Peter Frøhlich Staanum
Thomas Lund Andersen
Birgitte Maria Nielsen, sekretær



PROGRAM - 20. DSMF Symposium

Tirsdag d. 23. april 2024

Session	Tid	ONKOLOGI	NUKLEARMEDICIN	RADIOLOGI
	09.30 - 10.00	**Registrering og kaffe**		
	10.00 - 10.15	**Introduktion & firmapræsentation**		
1	10.20 - 11.05	**Karriereveje og forskning, Stråleterapi #1** ***(Kari Tanderup, AUH)***		
2	11.15 - 12.00	**Karriereveje og forskning, Stråleterapi #2** ***(Ivan Richter Vogelius, Rigshospitalet)***		
	12.00 - 13.00	**Frokost**		
3	13.00 - 13.40	**Ung fysiker pris 2024**		
	13.40 - 14.45	**Firmaudstilling & Poster session**		
	14.45 - 15.00	**Kaffepause**		
4	15.00 - 16.00	**EFOMP: Roles, demands and requirements of the medical physicist** ***(Efi Koutsouveli, EFOMP President)***		
	16.00 - 16.30	**Pause & Check-in**		
	16.30 - 18.30	**DSMF generalforsamling 2024**		
	18.30 - 19.00	**Pause**		
	19.00 -	**Festmiddag inkl. vinmenu & bar og musik**		
Onsdag d. 24. april 2024				
5	9.15 - 10.00	**UTH-gennemgang af strålebeskyttelsesområdet for alle grenspecialer** ***(Anders Beierholm, SIS)***		
	10.00 - 10.20	**Kaffepause**		
6	10.20 - 11.05	**Karrierevej og forskning: Radiologi** ***(Adam Espe Hansen, Rigshospitalet)***		
7	11.15 - 12.00	**Therapy with radioactive drugs from a medical physics perspective** ***(Katarina Sjögreen Gleisner, Lund)***		
	12.00 - 13.00	**Frokost**		
8	13.00 - 13.45	**Jagten på UTH'en i Dansk stråleterapi - Præsentation af statistik og handleplaner fra DSMFs nationale UTH SIG (Annette Ross Jakobsen, Harald Spejlborg, Martin Berg)**	**Dosimetry-guided radionuclide therapy** ***(Katarina Sjögreen Gleisner)***	**Photon counting CT – Clinical applications** ***(Janus Mølgaard Christiansen & Martin Weber Kusk)***
9	13.55 -14.55	**Innovation i sygehussektoren** ***(Brian Holch Kristensen, Bispebjerg Hospital)***		
	14.55 -15.00	**Tak for denne gang!**		

ABSTRACTS - PROGRAM

Session 1

Karriereveje og forskning, Stråleterapi # 1
Kari Tanderup, Aarhus Universitetshospital

En karriere inden for forskning i stråleterapi kan formes ved at være proaktiv, træffe gode valg og udnytte mulighederne.

Har du den rigtige baggrund?
Uanset om du forestiller dig en karriere inden for f.eks. klinik, forskning, produktudvikling eller administration: en bred orientering inden for klinisk medicinsk fysik kan give dig indblik i kliniske arbejdsgange, kliniske mål for stråleterapi samt betydningen/relevansen/potentialet af nye udviklinger. Uddannelsen til medicinsk fysiker kan give dig disse kompetencer og alternativt kan du opsøge andre muligheder for kliniktræning og eller -ophold. Grundlæggende og avancerede kurser inden for stråleterapi er også tilgængelig f.eks. gennem ESTRO. Hvis du drømmer om en forskerkarriere er et ph.d.-studie selvfølgeligt det første skridt i den retning. Udforsk mulighederne på dit universitet og på andre universiteter. Hold også øje med kurser i forskning i stråleterapi: ESTRO har flere kurser. På ESTRO-kurser kan du møde du undervisere og fagfæller, som kan blive professionelle partnere og gode venner.

Hvordan vælger du dit felt?
Når du vælger et felt, kan du tage hensyn til relevansen i de næste årtier. Hvad har potentiale i din egen afdeling? Passer dine interesser med de nuværende aktiviteter i din afdeling? Hvad har interesse og potentiale på den internationale scene? Tænk på, hvilken indflydelse din forskning og udvikling vil have: 1) Hvor mange patienter bliver behandlet? 2) Hvad er udsigterne over de næste år? 3) Hvordan kan din forskning ændre klinisk praksis? Endelig skal du vælge dit felt med passion!

Har du det rigtige netværk?
Netværk inden for og uden for din institution er af enorm betydning for din karriere. De fleste af os arbejder inden for højt specialiserede områder, og du vil have gavn af at finde fagfæller, der har de samme interesser på tværs af afdelinger og lande. Lang- eller kortvarige udvekslinger øger dit netværk og udvider dit udsyn. Hold øje med jobmuligheder i udlandet. Tøv ikke med at skrive e-mails til kolleger med dit CV og dine interesser. Desuden har ESTRO mange aktiviteter, hvor entusiastiske unge mennesker er meget værdsatte for at bidrage til projekter.

Hvordan skaber du muligheder?
Et godt CV er ikke kun en masse publikationer. Talent og erfaring med samarbejde og organisation har stor værdi inden for medicinsk fysik. Dit aktive bidrag til din afdeling og internationalt skaber muligheder. Det kan f.eks. være koordinering af projekter/møder, udførelse af målinger, støtte til dine mentorer og hjælp til fagfæller. Bank på professorens dør og spørg "Hvad kan jeg gøre for at bidrage?". De bedste investeringer for din karriere er ofte langsigtede og vil ikke umiddelbart kunne ses på dit CV eller i din PhD afhandling.

Session 2

Karriereveje og forskning, Stråleterapi # 2
Ivan Richter Vogelius, Rigshospitalet.

Session 3

Ung fysiker pris 2024

Clinical experiences with online adaptive radiotherapy of patients with vulvar carcinoma

Malene E. Bak, Nikolaj K.G. Jensen*, Trine J. Nøttrup*, Hanne F. Mathiesen*, Henrik Roed*, Maria Sjölin*, Flemming Kjær-Kristoffersen*, Vibeke N. Hansen*, Ivan R. Vogelius*,***

**Rigshospitalet, Department of Oncology, Copenhagen, Denmark*

***Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark*

Purpose:
The aims of this study are to test whether online adaptive radiotherapy (ART) is relevant for patients with vulvar carcinoma and if it improves target coverage and/or reduces dose to organs at risk (OAR) as well as investigate the adaptive workflow with respect to treatment time, rate of adaption and the workload of manual editing.

Materials and methods:
20 patients with vulvar carcinoma (527 fractions) were treated with online adaptation on a Varian Ethos accelerator which was installed in the clinic in January 2021. Setup CBCTs were acquired daily for adaptive planning and verification CBCTs were acquired immediately prior to dose delivery. CTV and PTV dose coverage and mean dose to bladder and rectum were extracted from scheduled and adapted plans as well as from adapted plans recalculated based on verification CBCTs. In addition, analysis of the decision of the adaptive procedure was performed for 17 patients (465 fractions) by completion of a questionnaire that was filled out by the treating RTT's and physician. The questionnaire included details on number of manual edits of OARs and targets and reason for choosing either the scheduled or adapted plan of the day. Adaption time was also recorded from the first CBCT scan to the second verification CBCT scan. This time included evaluation and re-contour of the target and OAR structures, dose calculation of the plans, plan choice and approval and lastly the QA process.

Results:
Mean CTV D95% and standard deviation was 98% ± 5% for the scheduled plan compared to 100.0 ± 0.3% and 100.0 ± 0.8% for the adapted plan on the setup and verification CBCT respectively. Dose to OARs varied substantially and did not show any benefit from adaption itself, however a margin reduction was implemented after the first patients treated. The adapted plan was chosen in 63.5% of the fractions and dominant reasons for not adapting were "no significant dose gain" (75 fractions, 14%) or "Medical doctor nor available for treatment" (50 fractions, 9.5%). Median adaption time was 15 minutes.

Conclusion:
Online ART has become our departmental standard offer for patients with vulvar carcinoma. There is a significant improvement to CTV dose coverage compared to IGRT. The adaptive workflow is robust with respect to the longer treatment time. No significant dosimetric gain is observed for OARs. We observe

that certain patients have a low rate of adaptation which most frequent can be explained by no relevant dosimetric gain using the adapted plan compared to the scheduled plan. Another frequent reason for not using the adapted plan is that no physicians are available at the accelerator during treatment. The need for specialized physicians trained in daily adaption is therefore critical for complex cases, whereas simpler adaptation cases can be performed by RTT's.

Session 4

EFOMP: Roles, demands and requirements of the medical physicist

Efi Koutsouveli, EFOMP President
Medical Physics and Radiation Protection Expert, Laser Safety Officer, Hygeia Hospital, Athens Greece
President of the European Federation of Organisations for Medical Physics (EFOMP),
president@efomp.org

Introduction

The European Federation of Organisations for Medical Physics (EFOMP) was founded in May 1980 in London to serve as an umbrella organisation for all NMOs (National Member Organisations). The current membership covers 37 National Member Organisations which together represent more than 10000 medical physicists and clinical engineers working in the field of medical physics. The EFOMP office moved from York, UK to Utrecht, Netherlands in January 2021. NMOs are the voting members of the Federation whereas Individual Associate and Company Members are non-voting members. EFOMP is run entirely by volunteers and is a non-profit organisation that aims to foster the activities of its National Members, encourage the formation of Medical Physics societies where none exists, coordinate the exchange and dissemination of professional and scientific information, develop guidelines for education, training and accreditation programs, make recommendations on the responsibilities, organisational relationships and roles of medical physicists and facilitate exchange of medical physics expertise.

Methods

EFOMP achieves its mission through the six advisory committees (Communications & Publications, European & International Matters, Education & Training, Professional Matters, Projects, Science), the European School for Medical Physics Experts, the European Congress of Medical Physics (ECMP), the European Journal of Medical Physics (EJMP). EFOMP has a goal to improve and harmonize education and training of Medical Physicists across all its member european societies in line with the EU guidelines and directives. Several Policy Statements have been published; on the level and content of Medical Physics Education and Training Schemes, on the roles, responsibilities, competences and status of the Medical Physicists, on recommended guidelines on National Registration Schemes for Medical Physicists and on Continuous Professional development. In 2023 the "Malaga Declaration" which provides a direction to the future development of the profession in Europe was updated.

Over the years, surveys were carried out to get an overview of the level of education and training programs across the European countries which showed significant variations on the entrance level, duration and contents of the current training programs. Approved National Registration Schemes by EFOMP, i.e the national systems for education, training and registration of MPEs, are intended to improve harmonization of the knowledge, practical skills and academic competences of MPEs. Developing education and training schools on specific subfields of Medical Physics, creating e-learning platforms, developing CC for MPEs in all clinical subspecialties and promoting the MPEs identity and mobility were some of the steps to be taken along the way.

A recent structure of EFOMP are the Special Interest Groups (SIGs). **The SIGs are** *networks of medical physicists and healthcare professionals working in specific areas of Medical Physics*. **The SIGs aim to fulfil the need for networking, education, research and professional exchanges in those fields by organizing webinars, symposia and schools, writing guidelines and policy statements, developing and taking part in projects, interacting with other medical organisations,** contributing in the development of Medical Physics curricula**.**

Results

The harmonisation of education and training of Medical Physics in Europe has been a cornerstone of EFOMP's mission since its foundation. Policies, Guidelines and Core Curricula (CC) serve as guidance documents for all Member countries to improve their training frameworks. Common training platform across Europe is a key development to the Medical Physics free movement between countries and automatic recognition of qualifications in all European countries.

EFOMP is currently preparing an application to seek approval from the EU to recognize and protect the title of the Medical Physics Expert. This action will affect transfer of medical physics skills and competences between European NMOs, prevent unqualified personnel from using the MPE title and elevate quality of healthcare services.

Conclusion

The EFOMP Strategic Agenda for the period 2024-2026 is founded upon a strong commitment to social, economical, environmental and ethical sustainability and embrace practices which contribute to a sustainable future for our profession, organisation and society. We can only achieve this with the support of our NMOs by nominating colleagues in committees, special interest groups, working groups and other EFOMP entities. Furthermore, EFOMP mentors, empowers and trains the future generation of Medical Physicists by building and supporting the Early Career Special Interest Group and give to its members observer roles within EFOMP structures, an action that would ensure continuity, innovation and adaptability.

Session 5

UTH-gennemgang af strålebeskyttelsesområdet for alle grenspecialer

Anders Beierholm, SIS

Anders Ravnsborg Beierholm, Britta Højgaard, Tina Hybertz Andersen, Sundhedsstyrelsen, Strålebeskyttelse

Introduktion

Utilsigtede hændelser, der sker i sygehusvæsenet, skal indberettes i den danske patientsikkerhedsdatabase, DPSD. En hændelse, der involverer ioniserende stråling, skal kun særskilt indberettes til Sundhedsstyrelsen, Strålebeskyttelse (SIS), hvis hændelsen har resulteret i eller kunne have resulteret i akutte stråleskader hos patienten, eller hvis den har resulteret i utilsigtet bestråling af arbejdstagere. De fleste hændelser med ioniserende stråling indrapporteres således ikke til SIS. Med henblik på at sikre læring om hændelser samt vurdere overordnede tendenser, har SIS en aftale med Styrelsen for Patientsikkerhed (STPS) om at kunne gennemgå relevante hændelser.

Metoder

SIS har en aftale med STPS om periodisk gennemgang af utilsigtede hændelser, der kan være af strålebeskyttelsesmæssig relevans. Denne gennemgang foregår periodisk ved anonymiserede

dataudtræk fra DPSD, som gemmes i oversigtsform lokalt hos STPS. Gennemgangen af hændelser foregår 3-4 gange om året. Søgningen efter hændelser foretages i en periode på enten 3 eller 4 måneder, afhængig af interval siden sidste læsning, og med tre måneders forsinkelse. Derved sikrer man sig, at gennemgangen kun vedrører hændelser, der er færdigbehandlet, da der er 90 dages frist for afslutning. Dataudtrækket gennemgås af tre sagsbehandlere fra SIS, og hændelserne kategoriseres i forhold til afdelingstype, primær årsag og konsekvens. En hændelse kategoriseres typisk kun inden for en enkelt afdelingstype, men kan have mere end en årsag og mere end en konsekvens.
Der tages udgangspunkt i resultaterne for hændelser indrapporteret i 2023. På grund af de tre måneders forsinkelse har alle tal for 2023 dog ikke været tilgængelige før abstract deadline. Nedenstående er derfor baseret på hændelser oprettet i DPSD i perioden 1. januar til 30. september 2023.

Resultater
Af de gennemgåede hændelser var 177 relateret til røntgendiagnostik, 160 til stråleterapi og 39 til nuklearmedicin.
For røntgendiagnostik var flest hændelser relateret til omgåelse af henvisninger eller procedurer (34 %), hardwarenedbrud (17 %) og menneskelige fejl (15 %). Forveksling af patienter samt undersøgelser, hvor højre og venstre side af kroppen ombyttes, tegnede sig for 13 % af hændelserne for røntgendiagnostik. Hændelser relateret til brug af kontrast udgjorde 4 %, og i 8 % af hændelserne sås der fejl i henvisningen.
Af de kategoriserede hændelser for stråleterapi var 33 % relateret til lejring af patienten forud for behandling, og 9 % var relateret til behandlingsplanlægningen. Der sås endvidere mange hændelser med omgåelse af henvisninger eller procedurer (24 %) og menneskelige fejl (18 %). Mangelfuld kommunikation personalegrupperne imellem sås i 16 % af hændelserne.
For nuklearmedicin var hændelserne primært relateret til omgåelse af henvisninger eller procedurer (26 %), subkutane injektioner (26 %) og menneskelige fejl (21 %).

Konklusion
Mange utilsigtede hændelser forårsages af menneskelige fejl som følge af stress, uopmærksomhed og bevidst eller ubevidst omgåelse af arbejdsgange, som kan være svære at forebygge. En del af hændelserne kan dog undgås ved at fokusere på fysiske og teknologiske barrierer, oplæring af personale ved introduktion af nyt apparatur samt ved at styrke kommunikation og ansvarsdeling ved overgange mellem forskellige personalegrupper.
SIS bruger ikke konkrete hændelser som baggrund for tilsynsvirksomhed og noterer sig blot generelle betragtninger og statistik over hændelsernes klassifikation. Men de periodiske gennemgange af hændelser kan bruges som input i den overordnede planlægning af tilsyn på strålebeskyttelsesområdet, hvor tendenser i hændelserne kan indgå som fokuspunkter i interviews og ved gennemgang af arbejdsgange og procedurer på afdelingerne.

Session 6

Karrierevej og forskning: Radiologi

Adam Espe Hansen, Rigshospitalet

Baggrund: Jeg har en karriere på tyve år i sundhedsvæsenet beskæftiget mig med skanning, primært MR skanning, men også nuklearmedicin og en smule CT. I det følgende vil jeg beskrive min karrierevej med eksempler på forskning.
Min karrierevej: Jeg er uddannet fysiker fra Københavns Universitet. I 2004, med en PhD og Postdoc i nanofysik i bagagen, blev jeg MR fysiker i en nystartet MR forskningsenhed på Glostrup Hospital med en 3 Tesla skanner. Forskningen var centreret om funktionel MR og blodgennemstrømning med tæt samarbejde med flere kliniske afdelinger. I 2012 skiftede jeg til Afdeling for Klinisk Fysiologi og Nuklearmedicin på Rigshospitalet som fysiker ansvarlig for PET/MR, en af de første kliniske skannere. Attenuationskorrektion på basis af MR var et forskningstungt emne, suppleret af mange kliniske projekter og senere MR hyperpolarisering. Jeg blev hen ad vejen klinisk lektor og hospitalsfysiker i Nuklearmedicin. I 2020 fik jeg et klinisk professorat knyttet til Afdeling for Røntgen og Skanning på Rigshospitalet og Københavns Universitet. Min forskning gør blandt andet brug af perfusionsbilleder og kunstig intelligens. Jeg arbejder især sammen med Onkologi, Neurologi og Neurokirurgi og underviser på medicinstudiet.
Perspektiv: Nye teknikker og software giver et vedblivende stort behov for fysikere og andre ikke-lægelige akademikere i radiologi og medicinsk billeddannelse generelt.

Session 7

Therapy with radioactive drugs from a medical physics perspective

Katarina Sjögreen Gleisner, Lund

Radionuclide therapy, a.k.a. molecular radiotherapy (MRT), refers to the use of internally distributed, unsealed radioactive substances for the treatment of benign and malignant diseases. These radioactive drugs, or radiopharmaceuticals, are often based on the combination of a radionuclide with a disease-targeting molecule. The mechanism of treatment is with ionising radiation.

The field of radionuclide therapy is developing rapidly, and several new drugs are being developed for various metastatic cancers. Today, the treatment of metastatic neuroendocrine tumours with 177Lutetium-labelled somatostatin analogues is established, and in the year 2022 177Lutetium-labelled prostate-specific membrane antigen (PSMA) gained marketing approval in the EU for the treatment of metastatic castration-resistant prostate cancer. To achieve a higher treatment effect, radiopharmaceuticals labelled with alpha-emitting radionuclides are currently being developed where the alpha radiation provides a substantially higher radiobiological effect.

An advantage with radioactive drugs is that, thanks to the radioactive label, they can be imaged in the patient. The treatment can thus be followed in real time, using nuclear-medicine imaging (SPECT/CT). Acquisition of several images and embedding physics-based corrections in the tomographic reconstruction enable quantification of the activity, the pharmacokinetics, and the radiation doses delivered to tumour tissue and normal organs. Still, contrary to other kinds of radiotherapy, radionuclide therapy is generally administered in fixed amounts to all patients, without consideration of radiation doses to tumours or normal tissues. However, as in any radiotherapy, there is a connection between the radiation dose and the treatment effect, as well as the risks of side effects of normal tissue.

This presentation aims to give an overview of MRT, its present status with a view towards the future, from the perspective of a medical physicist.

Session 8

ONKOLOGI:

UTH national gruppe: patientsikkerhed

Cheffysiker Annette Ross Jakobsen (Aalborg Universitetshospital, Afdeling for Kræftbehandling, Afdelingen for Medicinsk Fysik), fysiker Harald Spejlborg (Kræftafdelingen, Medicinsk Fysik, Aarhus Universitetshospital) og cheffysiker Martin Berg (Afdeling for Medicinsk Fysik, Onkologisk Afdeling, Sygehus Lillebælt).

Den specielle interessegruppe 'National patientsikkerhed inden for stråleterapi' under DSMF har eksisteret igennem en årrække. Siden 2023 er der mere formelt til understøttelse konsensus og systematik i læring af utilsigtede hændelser (UTHer) på tværs af landet arbejdet ud fra et kommissorium. Fordelingen af UTHer for 2023 er samlet og viser, at stråleterapi i Danmark er en meget sikker behandlingsform. Gruppen udvælger særlige fokusområder for cirka et år ad gangen. I 2023 har der været særligt fokus på de UTH'er, som opstår i planlægningsfaserne af strålebehandlingen. I det kommende år vil der blive udarbejdet en national tilpasning og underopdeling af koder baseret på det engelske Radiotherapy Pathway Coding-system. Dette vil generere mere detaljeret viden om, hvor UTHer opstår, hvilket tænkes anvendt til ultimativt at levere en oversigt over, hvordan de særligt kritiske processer bedst kvalitetssikres.
Konkret præsenteres kommissoriet, data for UTHer inden for stråleterapi i 2023 herunder særligt fokus på gruppens arbejde i 2023 samt gruppens fokus det kommende år.

NUKLEARMEDICIN:

Dosimetry-guided radionuclide therapy

Katarina Sjögreen Gleisner

Dosimetry in radionuclide therapy has the potential to optimise and personalise treatment. European radiation-protection legislation require that radionuclide therapy should be considered a radiotherapeutic procedure, based on the premise that absorbed doses to delivered to target tissues should be optimised while absorbed doses to non-target tissues should be as low as reasonably achievable. This approach necessitates individualised treatment planning and verification, based on dosimetry. Still, radionuclide therapy is mostly administered in fixed amounts to all patients, possibly with consideration of the patient weight or body surface area, and without consideration of radiation doses to tumours or normal tissues. However, there are several applications or clinical studies in which dosimetry-based planning is incorporated as a key element in the treatment protocol.

The general formalism for absorbed-dose calculation, as provided by MIRD, can be applied at different levels, as well as for personalised dosimetry. A basic quantity to be estimated is the time-integrated activity in different source regions, which is then combined with estimates of the target region mass and the radiation absorbed fraction between source and target regions. The time-integrated activity is governed by the activity over time, and thus the pharmacokinetics of the radioactive drug. As the pharmacokinetics vary between individual patients, the time-integrated activity and absorbed doses to different target regions also vary.

Dosimetry-guided therapy planning thus relies on estimation of the pharmacokinetics for the individual patient - before the treatment has been completely delivered. This can be approached in different ways, for example using a surrogate radiopharmaceutical for pre-therapeutic assessment and imaging, or by fractionating the treatment.
Depending on the radionuclide used, there are variable options for treatment verification with post-therapeutic imaging. Technical challenges are associated with factors such as the radionuclide emission spectrum and the amount of administered activity. Image-based dosimetry offers 3D-resoloved dosimetry, and tools for its application are becoming increasingly available in the clinic.

Currently, as medical physicists, we have the questions, the tools, and there is an urgent need of data. Let's start digging!

RADIOLOGI:

Kliniske erfaringer med high-resolution og spektral Photon-Counting CT

Janus Mølgaard Christiansen & Martin Weber Kusk

Vi har i Esbjerg ca. 1 års erfaring med klinisk drift af photon-counting CT (PCCT). I vores oplæg gennemgår både forbedringer i diagnostik, dosis og arbejdsgange, men udfordringer, "børnesygdomme" og indtil videre uopfyldte potentialer.
PCCT giver højere jod-signal, hvilket har muliggjort en reduktion in kontrastdosis, på tværs af undersøgelsestyper. Virtuel monoenergetiske billeder er blevet den nye standard, men det arbejdes stadig på at finde frem til de optimale niveauer til forskellige kliniske problemstillinger. Især i CT cerebrum har justering af disse givet anledning til artefakter. Spektral billeddannelse giver også mulighed for fremstilling af Virtuel non-kontrast billeder, jod-densitets-billeder og andet, som potentielt kan medvirke til at reducere antallet af supplerende scanninger ved tilfældige fund. Eksempler på disse vil blive præsenteret og diskuteret.
Der har dog, indtil videre, været softwaremæssige begrænsninger som har betydet at man ikke kan foretage de samme analyser som ved Dual-Source, Dual Energy CT.
En anden fordel ved PCCT-detektor teknologien er muligheden for brug af sub-pixels til Ultra-High-Resolution (UHR) billeddannelse med 0.2 mm snit. Den har haft stor indflydelse på High-resolution CT af Thorax, hvor der er sket et kvantespring i billedkvaliteten, som i flere tilfælde har ført til revurdering af diagnoser i.f.t. konventionel CT. Teknikken er også taget i brug til alle perifere knoglescanninger, og vi er i samarbejde med kardiologerne begyndt at udforske anvendelsesmulighederne inden for kardiovaskulær CT, f.eks. ved koronar-stents. For optimal udnyttelse kræver det dog optimering af kernel og matrix, ligesom scantid og datamængde giver udfordringer.

Session 9

Innovation i sygehussektoren

Brian Holch Kristensen, Bispebjerg Hospital

Introduktion
Nytænkning og forandringsparathed synes mere vigtigt i sundhedsvæsenet end nogen sinde. Hvordan kan innovation bidrage til det, og hvad mener vi med innovation i den sammenhæng?
Metoder
I det koncept, vi har kaldt for *Behovsfabrikken*, forsøger vi at vende innovationen lidt væk fra teknologierne, men holde fokus på det behov vi ønsker at dække – ofte dog ved hjælp af innovative teknologier. Her er påstanden så, at det i sidste ende faktisk skaber bedre innovative og reelt fungerende sundhedsløsninger.
I stedet for fx at købe/udvikle en AI-teknologi, der hurtigt identificerer en fraktur på et røntgenbillede, så køb/skab en sammenhængende løsning, der skaber et bedre flow for patienter i en skadestue, der mistænkes for at have brækket armen. Det er meget nemmere at værdisætte og dermed finde betalingsvillighed bag.
Resultater
Med et sundhedsbehov i fokus har vi netop annonceret et såkaldt innovationspartnerskabsudbud, hvor vi søger at dække en problematik omkring (bare et eksempel) de mange nye enestuer på supersygehusene. Opgaven er at skabe sammenhængskraft og kliniske overblik på sengeafsnit med kun enestuer.
Jeg vil gennemgå tankerne bag sådanne udbudsformer og måske forklare hvorfor de også kan være relevante indenfor medicoteknologien.
Konklusion
Vi er de første i DK der reelt bruger disse omvendte udbud og værdibaserede/innovative indkøb, så erfaringen er ikke stor og jeg håber at vi på mødet kan diskutere, hvorledes man som hospitalsfysiker kan bidrage med denne dagsorden og sætte reelle svære kliniske behov i spil.

ABSTRACTS

Posters

Kontrol af måleudstyr i Sundhedsstyrelsens Standarddosimetrilaboratorium

Anders Ravnsborg Beierholm, Peter Kaidin Frederiksen; Sundhedsstyrelsen, Strålebeskyttelse

Formål
Sundhedsstyrelsen opretholder et akkrediteret laboratorium for standarddosimetri, hvor alle målestørrelser er sporbare til SI-systemet. Hovedformålet med laboratoriet er at sikre, at Sundhedsstyrelsens egne måleinstrumenter til brug ved tilsyn og beredskabssituationer er funktionsdygtige og retvisende, samt at yde måletjenester til Sundhedsstyrelsens akkrediterede persondosimetrilaboratorium. Laboratoriet er en del af IAEA/WHOs netværk af laboratorier (SSDL).
Her præsenteres resultater for visse ydelser for udvalgte typer af Sundhedsstyrelsens egne instrumenter, da disse resultater kan være relevante for andre instrumentbrugere.

Metoder
Kontrol af miljødosimetre: Instrumenter af typerne RadEye B20-ER, RadEye G-10, RadEye G-10^{Ex} og Rados RDS-110 er kontrolleret med hensyn til linearitet og energiafhængighed af målt $H^*(10)$ i strålekvaliteterne ^{241}Am, ^{137}Cs og ^{60}Co, iht. ISO/IEC 60846-1:2014. Ved kontrollen benyttes en OG-8 kildekarrusel fra VF.

Kontrol af elektroniske persondosimetre: Instrumenter af typen Tracerco PED-IS er kontrolleret med hensyn til energiafhængighed og linearitet af målt $H_p(10)$ i strålekvaliteterne ^{137}Cs (662 keV) og ^{60}Co (1173 og 1333 keV), iht. ISO/IEC 61526:2010. Til denne kontrol bruges også OG-8 kildekarrusellen.

Kontrol af overflademonitorer: Instrumenter af typerne RadEye B20-ER og RadEye AB-100 er kontrolleret med hensyn til angivet måleeffektivitet, iht. IEC 60325:2002 og IEC 62363:2011 ved hjælp af sporbare 10 cm x 15 cm fladekilder (^{14}C, ^{36}Cl, ^{90}Sr og ^{241}Am), som opfylder ISO/IEC 8769:2016. Kilderne dækker et anbefalet energispektrum af α- og β-energier.

Resultater
Ved kontrol af miljødosimetre opfyldte fem af otte B20-ER standardens tolerancer mht. linearitet (-15 til 22 %) og energiafhængighed (-29 til 67 %). Der sås en betragtelig variation imellem de enkelte instrumenter. Alle de kontrollerede G-10, G-10^{Ex} og RDS-110 opfyldte tolerancerne, og variationen mellem de enkelte instrumenter lå som forventet iht. usikkerhedsbudgettet (6 %, k = 2).

Ved kontrol af overflademonitorer opfyldte fire af fem AB100 standardens tolerance ift. måleeffektivitet (± 25 %), iberegnet den nuklidspecifikke usikkerhed på 7-13 % (k = 2). Et enkelt instrument overresponderede med ca. 80 % mht. ^{14}C, som er nuklidet med den laveste middelenergi (49 keV). Til sammenligning underresponderede fem af fem kontrollerede B20-ER med ca. 40 % for ^{14}C, hvorimod de fleste instrumenter opfyldte standardens tolerancer for de øvrige tre nuklider.

Ved kontrol af elektroniske persondosimetre opfyldte fire af fire PED-IS standardens tolerancer mht. linearitet (-15 til 22 %) og energiafhængighed (-29 til 67 %), og variationen mellem de enkelte instrumenter lå inden for det forventede niveau opstillet iht. usikkerhedsbudgettet (6 %, k = 2).

Konklusion
Kontrol af instrumenter giver tillid til brug på tilsyn, ved vagtopgaver og i beredskabssituationer. Kontrollen af Sundhedsstyrelsens egne måleinstrumenter viser, at forskellige eksemplarer af samme type instrument i visse tilfælde kan udvise stor variation, men det enkelte instrument er i de fleste tilfælde stabilt fra kontrol til kontrol. Kontrollens resultat bør vurderes i lyset af instrumentets konkrete brug, og brugeren af instrumentet bør på baggrund heraf foretage en risikovurdering af instrumentets egnethed.

Characterization of count rate performance in a Long Axial Field of View PET Scanner

(poster presented at IEEE MIC in Vancouver, November 2023)
Thomas L. Andersen, Julie V. Henriksen1, Søren Holm, and Flemming L. Andersen

Introduction: The noise equivalent count rate (NECR) as specified by the NEMA NU-2 2018 protocol using a 70 cm long line source is inadequate for count rate performance characterization when the axial FOV exceeds 70 cm in Positron Emission Tomography (PET) scanners. Here we present non-NEMA count rate performance data on a Siemens Vision Quadra LAFOV PET/CT scanner with a FOV of 106 cm. using a humanoid phantom.

Methods: A whole-body phantom was constructed to mimic a patient scanning scenario. The phantom consisted of phantoms for the brain, thorax, abdomen (including bladder) and legs. The phantom approximately corresponds to a 60 kg patient. The phantom was filled with [^{18}F]FDG (a total of 2242 MBq @ scan start) and scanned for 28hrs: 5 min. scans every 20 mins. for 8 hrs, 5 min. scans every 30 mins. until 12 hrs and 5 min. scans every 60 mins. until 28 hrs. covering in total 15 half-lives. The noise equivalent count rate (NECR), proportional to the final reconstructed image signal to noise ratio, was calculated from the recorded trues, T, randoms, R, estimated by the delayed window method and scatter, S as:

$$NECR = \frac{T^2}{T + S + 2 \cdot f \cdot R}$$

where f is the ratio of the phantom width to the width of the sinogram, in this case 0.33.

Results and discussion: Peak NECR for our realistic activity distribution phantom was 1.02 Mcps @ 17.3 kBq/ml which is at a lower point than the previously published NEMA NECR value of 28.3 kBq/ml [1]. The peak NECR value from our data was determined by an electronic bottleneck, i.e., hardware countrate of data transmission from the scanner which is limited rather than detector deadtime. Near the peak of the NECR curve (the “break point”), the NECR curve has a differential quotient close to zero suggesting that little image quality gain is obtained from increased total activity at this level. For clinical use, the standard recommended injected radioactivity of 3 MBq/kg is not compromised although the (relative) slope of the NECR curve here is already reduced to 47% compared to the maximum slope suggesting that a lower injected dose should be used if radiation levels to surroundings or absorbed dose to a patient is of concern. Activity concentration reduction from 3 MBq/kg to 0.3 MBq/kg can be compensated by an increase in time by a factor 7 estimated from the current data. Only at concentrations below 0.01 kBq/mL random corrections from the background will influence image quality.

Conclusion: The system is well suited to patient studies in the normal clinical range with wide possibilities for balancing activity versus time.

[1] A. Prenosil, M. Hentschel, M. Fürstner, H. Sari, A. Rominger, ” NEMA NU 2-2018 performance measurements of Biograph Vision Quadra PET/CT system”, Nuklearmedizin, 60 (02), 2021.

Sharing AI delineation functions in a national data infrastructure

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Purpose/Objective

In recent years, great leaps have been made in developing artificial intelligence (AI) solutions to many time-consuming processes in radiation therapy (RT). Several clinically viable solutions have emerged, predominantly for delineating targets and organs at risk (OARs). However, implementing such solutions in a clinical workflow may require time, financial resources and technical expertise, which is not always available, especially in smaller institutions.

Providing any RT centre with easy access to modern automatic delineation processes will reduce the technical and financial resources needed to experience their potential benefits. Additionally, centralising such processes enables more aligned implementations of national guidelines if the provided models are coordinated with the relevant national cancer groups.

This work proposes a method to share third-party data processing solutions, which could be based on AI or any other technology, using an existing infrastructure. It reports on the experienced time saving using one shared model at a smaller RT centre.

Material/Methods

The proposed solution recognises pre-defined features in the submitted DICOM data, which will trigger an automatic flow of forwarding them to a third-party destination and returning the results to the submitting centre once they have been processed. The data flow is outlined in Figure 1. In the example solution, the triggering feature is the image series description containing a specific text string.

The DcmCollab system [1], which connects all Danish RT centres to a central RT database using isolated network connections for DICOM communication, was used as a data infrastructure for the solution.

To evaluate the effect of the solution, a test flow providing an nnUnet AI head and neck delineation service was implemented. Medical doctors at a collaborating centre with limited computer scientific resources estimated the time saved using the provided solution.

Results

The total processing time from submitting an image set to the system to receiving an AI-generated OAR structure set is 10 to 15 minutes. Since the image set can be sent directly from the scanner, the AI-generated structure set is often ready when the image set is imported into the treatment planning system. Thus, the conventional treatment planning process is not delayed, while the OAR contouring process is sped up.

After routinely evaluating the delineations provided by the proposed solution, the clinicians in the participating centre reported an evaluated time-saving benefit of 30% - 40% compared to the manual workflow, with a potential for even greater savings with routine and slight optimisations of the AI model.

The solution was well received as a significant assistance in a time-pressed clinic.

Conclusion

The proposed solution is built on the pre-existing Danish DcmCollab infrastructure, but it is possible to implement similar mechanisms in other environments. In doing so, it is important to consider the legal challenges that might arise; the provided third-party data processing entity – in this case, the nnUnet delineation service – should be approved by the EU Medical Device Regulative, and strict version logging is necessary to be able to trace back any errors in the returned data. If the third-party data processing entity is a commercial product, licensing issues must also be addressed. Furthermore, the surrounding infrastructure should be tested and security evaluated.

The possibility to share cutting-edge automation tools beyond the most privileged centres has the potential to increase quality of care, and to release human resources across all participating RT centres. Therefore, we consider the technical and legal implementation costs of the solution worth the investment.

References

[1] A national repository of complete radiotherapy plans: design, Results, and experiences
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DOI: 10.1080/0284186X.2023.2270143

Figure

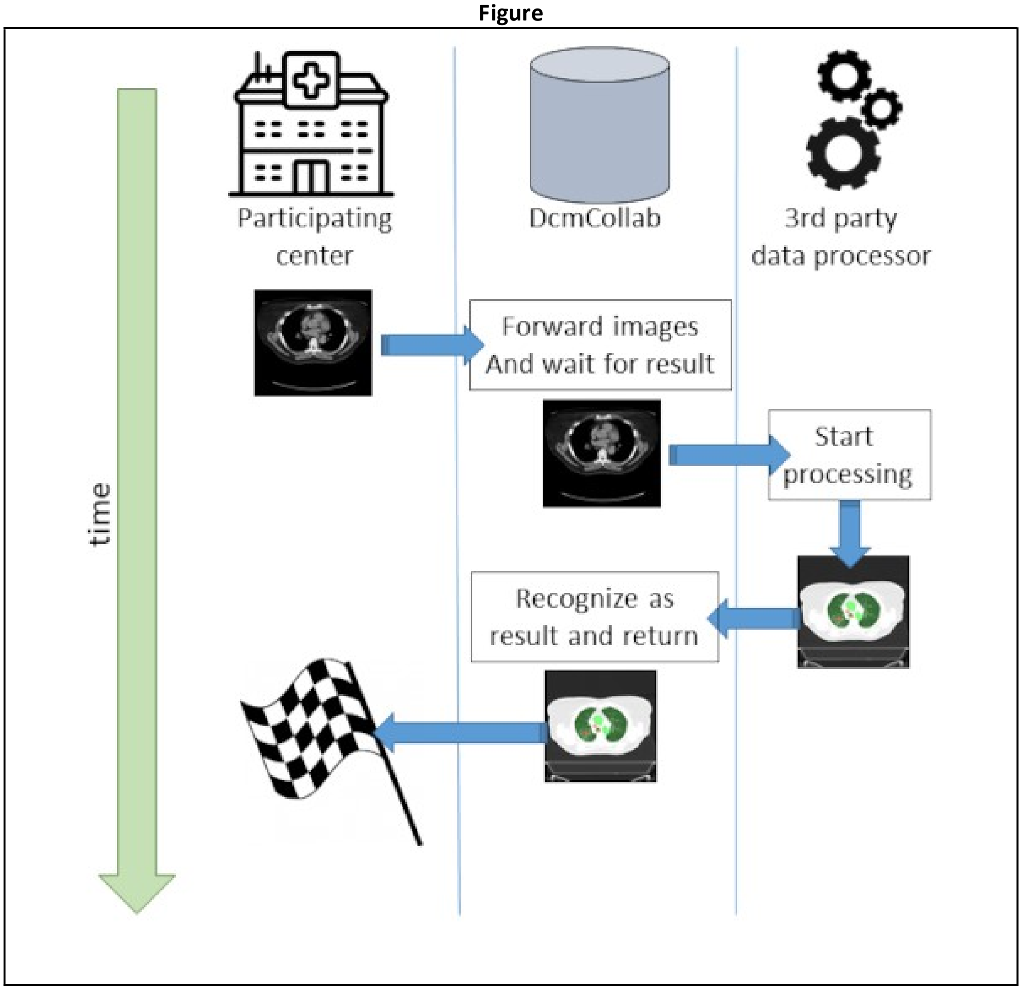

Figure 1

Helkropsparametrisk billeddannelse af perfusion i metastatisk prostatacancer ved brug af long axial field-of-view [^{15}O]H_2O PET

Lars Poulsen Tolbod, Nana Louise Christensen, Lars Christian Gormsen, Jens Sørensen, og Mads Ryø Jochumsen

Baggrund: Aggressive tumorer er ofte karakteriseret ved både øget metabolisme og perfusion. I klinisk PET/CT har fokus historisk været på metabolisme, da billeddannelse af perfusion kræver dynamiske skanninger med høj tidsopløsning og det har derfor ikke været muligt at lave helkrops-skanninger pga PET/CT skannerens begrænsede field-of-view (FoV). Med den nye generation Long axial FoV (LAFoV) PET skannere er det blevet muligt at lave dynamiske skanninger på over 1 meter med kortlivede perfusionstracere såsom [^{15}O]H_2O, hvilket muliggør kvantitativ vurdering af ikke bare primær tumor, men også metastatisk sygdom. I dette studie, har vi udviklet værktøjer til parametrisk billeddannelse af metastatisk prostatacancer.

Metode: Ti patienter med metastatisk prostatacancer fik udført en dynamisk LAFoV [^{15}O]H_2O PET (Siemens, Quadra) efterfulgt af [^{18}F]PSMA-1007 PET. Perfusion (mL/min/100 mL) blev estimeret ud fra en enkeltvævskompartmentmodel (1TCM) med billedinputfunktion automatisk deriveret fra hjertet. Parametriske perfusionsbilleder blev beregnet ved brug af en basisfunktionsmetode med forudgående voxelvis korrektion af signalforsinkelse (delay) bestemt ud fra leading-edge detektion.

Resultat: For 8 primære tumorer, 64 lymfemetastaser, og 85 knoglemetastaser, var median tumor perfusion henholdsvis 19 (15-27) mL/min/100mL, 16 (13-27) mL/min/100mL, og 26 (21-39). Der var glimrende korrelation mellem VOI-baseret beregning af perfusion og parametriske billeder ($r=0.99$, $p<0.0001$).

Konklusion: LAFoV PET imaging med [^{15}O]H_2O muliggør kvantitativ parametrisk billeddannelse af helkropstumorperfusion, en potentiel biomarkør til karakterisering af tumor og monitorering af behandlingsrespons.

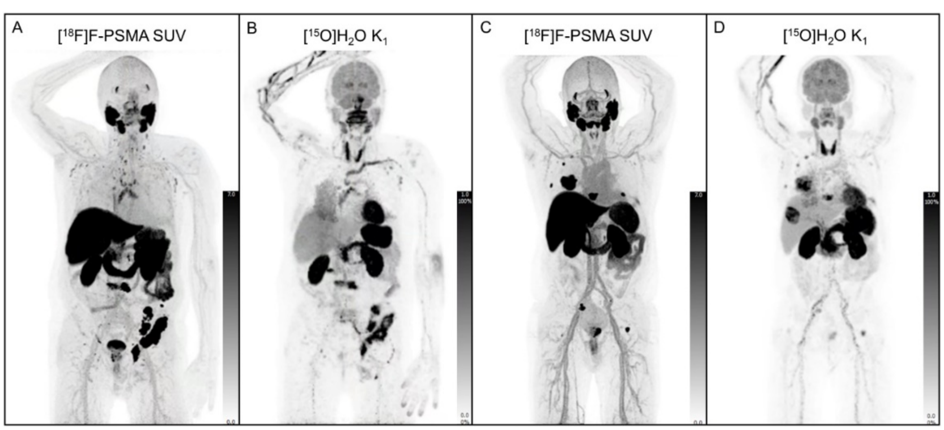

FIG. 1. *Maximum intensity projections (MiP) af [^{18}F]PSMA-1007 SUV billeder (A og C) og [^{15}O]H_2O K_1 (mL/min/mL) (B og D). Billederne af den første patient (A og B) viser øget perfusion i metastaser i bækken og ryghvirvler. Den anden patient (C og D) har en primær tumor, to små lymfeknudemetastaser samt flere knoglemetastaser med øget perfusion.*

The impact of the xSPECT bone algorithm on the recovery coefficients of small tumors: a phantom study with ^{177}Lu

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Purpose: The quantification of small tumors is still one of the challenges in bone imaging and dosimetry due to the partial volume effect. Although xSPECT (bone) algorithms are promising, image-based dosimetry after radionuclide therapy suffers from the partial volume effect, especially for small tumors with a volume of a few ml or less. Recovery coefficient (RC) values typically depend on image reconstruction and this may have an effect on small tumor quantification in post-treatment. In this phantom study we investigated the effect of xSPECT (bone) on the RC-values for SPECT/CT images.

Materials and methods: A 6 liter water-filled cylindrical PMMA phantom with an inner diameter of 21 cm was used. The top lid had cylindrical inserts. A 19 ml solid Teflon cylinder was used as bone equivalent and a 19 ml water filled cylinder was used as tissue equivalent. Both had a diameter of 25 mm. For creating different tumor inserts with a volume of 2, 1, and 0.5 ml a 2 ml point source holder and two syringes (5 and 10 ml) were used, where the dimension in all directions were of comparable size. The tumor inserts were filled with 1.4 MBq/ml ^{177}Lu. Three different inserts were directly placed on the Teflon cylinder and three different inserts on the water filled cylinder. There was no activity in the background.

Imaging was done with a Siemens Intevo Bold SPECT/CT scanner and images were reconstructed using iterative reconstruction with xSPECT, xSPECT bone and Flash3D. The effect of the reconstruction algorithms on the RC-values was determined by calculating the activity concentration in volumes of interests of the tumor inserts.

The volumes of interest were determined by both manually drawing the tumor inserts on CT and by a threshold method for comparison. For the latter method the threshold was adjusted to a value, so that the volume of the VOI was as close as possible to the known volume of the tumor insert.

Results: Near bone the xSPECT bone reconstruction performs better for the 2 ml inserts. The RC-value is approx. 100%, while the other reconstructions show a RC-value of typically 93%. In tissue the RC-values for all the reconstructions were lower for the 2 ml insert, typically 60-70%. For the 0.5 ml inserts RC-values were between 50% and 57% both close to bone and in tissue.

The RC-values determined by the threshold method showed similar behavior, but were generally slightly higher and with a larger spread. The RC-values for the 0.5 ml insert were between 52% and 72%.

Conclusions: In this phantom study it was possible to obtain a RC-value close to 100% for the 2 ml inserts near bone, when the xSPECT bone reconstruction algorithm was used. Just xSPECT seems to result in slightly lower RC-values, also compared to the Flash3D algorithm. Care has to be taken when using standard RC-curves for tumors close to the bone, since RC-values close to bone are higher than in tissue.

Key words: xSPECT (bone), recovery coefficient, ^{177}Lu, tumor, dosimetry

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