



Faculty of Health Sciences



PET/CT and PET/MRI

Prof. Liselotte Højgaard
Clinical Physiology, Nuclear Medicine & PET
Rigshospitalet, University of Copenhagen & Technical University of Denmark

November, 13th 2023 DTU



1


UNIVERSITY OF COPENHAGEN

RIGSHOSPITALET

Rigshospitalet




- University hospital
- 12.000 staff, 250 ph.d.s, 3500 publications, 120 professorer
- Founded in 1757 as the first hospital in the Nordic countries to cure patients and do research



2

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET



Department of Clinical Physiology,
Nuclear Medicine & PET
Annual Report 2017


PET
— 25 —
years anniversary
June, 21st 1992-2017

*The most grateful
thank you to
the John and Berthe
Meyer Foundation*


Rigshospitalet · University of Copenhagen

| | |
|------|---------------------------|
| 1991 | Scanditronc 22 MeV |
| 1991 | GEM96 PET Scanner |
| 1993 | NMJ Spectrometer |
| 1993 | PET Advance Scanner |
| 2001 | PET/CT Scanner |
| 2005 | PET/CT Scanner |
| 2005 | Cyclotron 2 |
| 2007 | HRRT Scanner |
| 2009 | Radioisotropy Synthesizer |
| 2011 | PET/MR Scanner |
| 2017 | PET/CT Scanner |

130.000 studies/year, 160 publikations, 200 staf, 25 Ph.d., 6 professors,
2 cyklotrons, 7 PET/CT, PET/MRI, micro-PET and MRI, ½ bio. dk.kr.



3



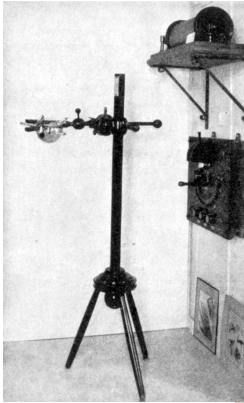
Liselotte Højgaard (1957), MD 1982, specialist clinical physiology & nuclear medicine.

Chair of Dept. of Clinical Physiology, Nuclear medicine & PET, 2000-2023
Rigshospitalet. Prof. University of Copenhagen and DTU.

Chair of The Danish National Research Foundation 2013-2018.
Editor, Ugeskrift for Læger 1996-2002. ICMJE, The Vancouver Group.
Chair EMRC, ESF 2006-2012. Chair EU AG Health research 2010-2017.
Board member the Novo Nordisk Foundation, Die Robert Bosch Stiftung, Stuttgart,
ERC Scientific Council.
The Royal Danish Academy of Sciences and Letters & ATV The Academy of
Technical Sciences.


4

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET




X-rays were described for the first time by Wilhelm Conrad Röntgen, Würzburg, in 1895.

1044 papers about X-rays in medicine were published in 1896.



DTU


The first X-ray machine Copenhagen 1896



5


UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Nuclear Medicine was born in Copenhagen




Nuclear Medicine was developed in Copenhagen by Georg de Hevesy & Niels Bohr and published in 1935.

Hevesy won the Nobel Prize in 1943 for the tracer technique.



DTU



6

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

A diagonal arrow points from the bottom-left to the top-right, indicating the progression of medical imaging technologies. Along the arrow, various milestones are marked with small images and text:

- Röntgen 1895**: Image of a hand showing X-ray shadows.
- Radioaktivitet Henri Becquerel, Marie et Pierre Curie 1903**: Image of laboratory equipment.
- Nuklearmedicin Hevesy & Bohr 1935**: Image of a person in a lab coat.
- PET USA 1951 MGH**: Image of a PET scanner.
- MR 1977/1984**: Image of an MRI scanner.
- CT 1972**: Image of a CT scanner.
- PET & cyklotron 21.Juni RH 1992**: Image of a cyclotron.
- PET/CT 2001**: Image of a PET/CT scanner.
- PET/MR 2011**: Image of a PET/MR scanner.
- PET/CT Total Body 2021**: Image of a total-body PET/CT scanner.

DTU RH

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Three vertical panels show PET/CT scan results: a grayscale CT scan of a human torso, a grayscale PET scan showing metabolic activity, and a fused PET/CT scan with a blue color scale. To the right is a large image of a PET/CT scanner with a patient bed.


DTU RH

PET/CT December 2001

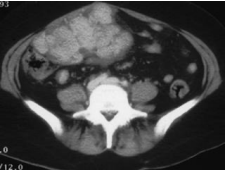
UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Diagnostic imaging in cancer

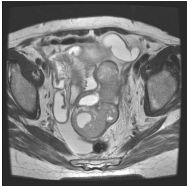
- Diagnosis
- Staging – how widespread is the disease ?
- Treatment effect
- Relapse – has the disease reappeared
- Planning of surgery and radiation therapy



DTU
Ultrasound

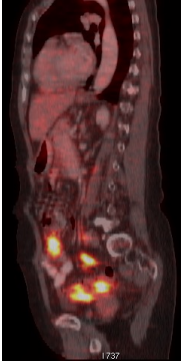


CT



MR

PET/CT



RH



CT and MRI have key roles for the diagnosis of orbital tumors

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Many diseases, many methods, which one ?

PET/CT

- Diagnostic accuracy – sensitivity and specificity
- Prize
- Side effects
- Availability
- Cost effectiveness
- > 10.000 articles

DTU **Ultrasound** **CT** **MR** **RH**

11

PET positron emission tomography

CT computer tomography

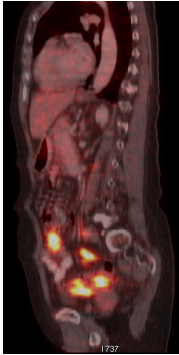
Annihilation Gamma rays 511 KeV

F-18 FDG: fluoro-deoxyglucose is a glucose analogue, showing glucose metabolism. Cancer cells have a high glucose metabolism; F-18 decays via positrons.

12

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET/CT-indications 2023





Dementia, brain tumors, Parkinson's disease

Heart - flow and metabolism

Oncology: staging, treatment effect, relapse, control, RTP- and OP-planning

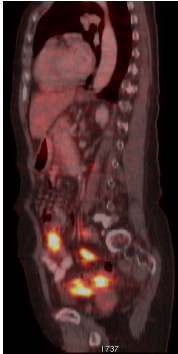
35.000 publications on PET

13




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET/CT as first line imaging

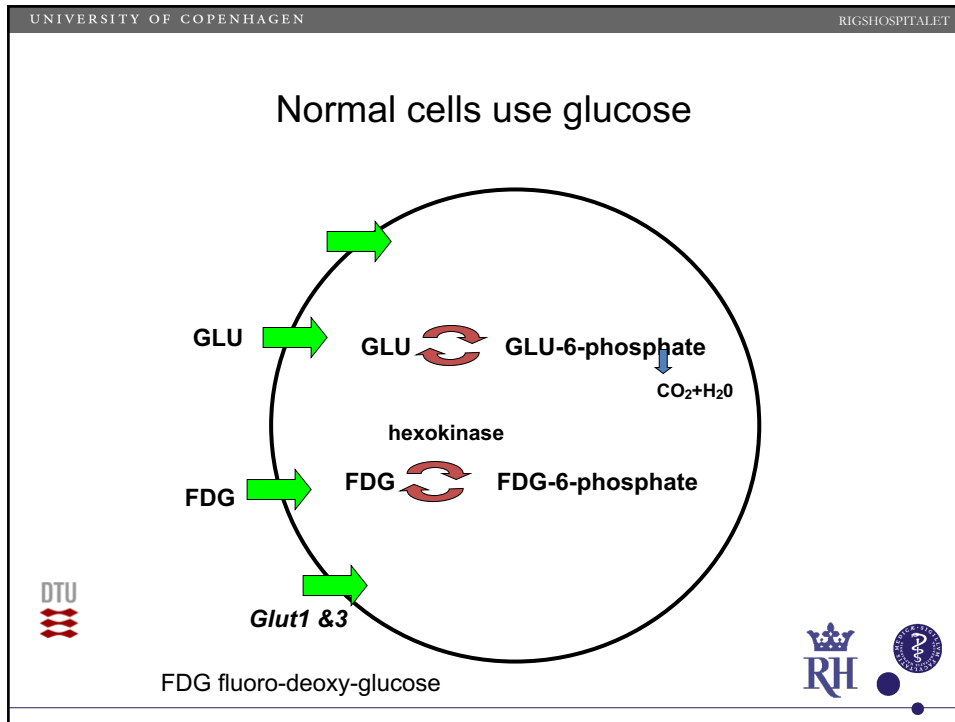


PET/CT with FDG is integrated in Danish routine patient work up "Kræftpakkerne"

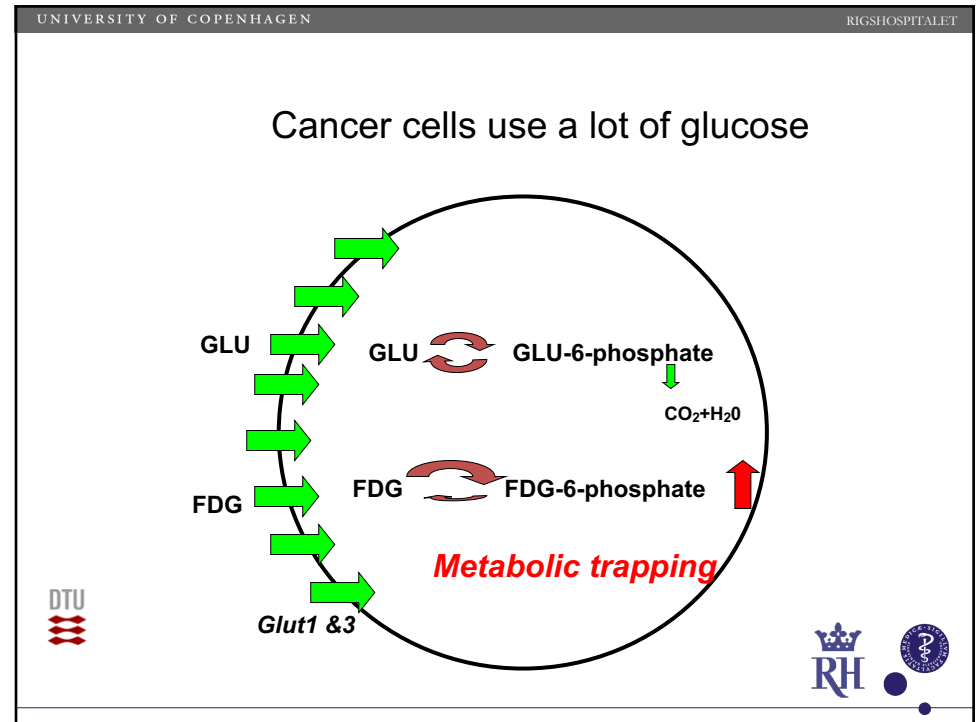
- Brain tumors
- Lung cancer
- Cervical and ovarian cancer
- Lymphoma
- Head & Neck
- Gastro-intestinal
- Sarcomas
- Malignant melanoma

14



15



16

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

| Radioisotope | Half-life (min) |
|-----------------|-----------------|
| ^{18}F | 109.8 |
| ^{11}C | 20.4 |
| ^{13}N | 9.96 |
| ^{15}O | 2.05 |

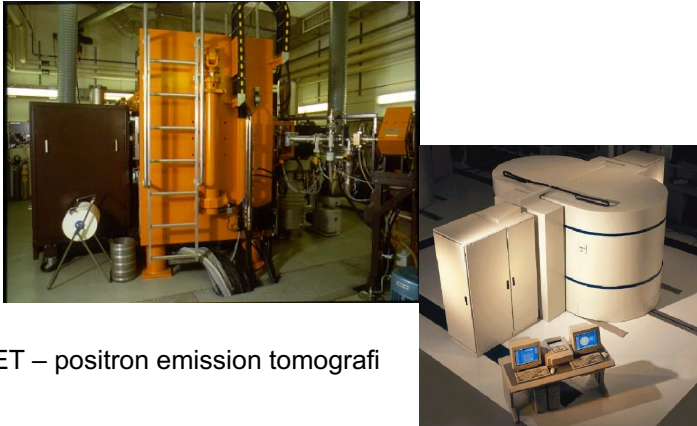
FDG: F-18 flouro-deoxy-glucose

DTU RH

17

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Cyklotrons for isotope production





PET – positron emission tomografi

DTU RH

18

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Radiochemistry Unit with lead hot cells

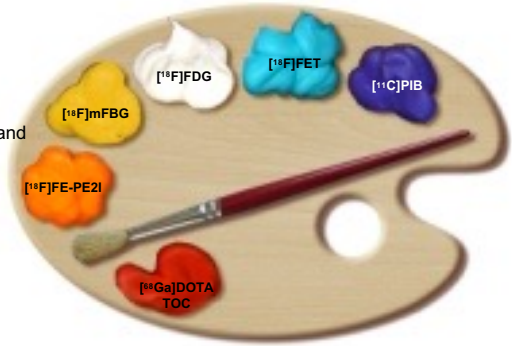



19




Tracers for PET

Tracers with different biology



For the diagnosis of different diseases and Functional imaging



20

| UNIVERSITY OF COPENHAGEN | RIGSHOSPITALET |
|--|---|
| PET tracers | Use |
| [F-18] FDG [F-18] Altanserin [C-11] CUMI-101 [C-11] DASB [C-11] Flumazenil [C-11] PIB [C-11] SB207145 [O-15] H ₂ O [N-13] NH ₃ [F-18] FLT [Cu-64] ATSM [Ga-68] DOTATOC [Ga-68] ABY-025 [F-18] FET | Onkology 5-HT _{2A} receptors 5-HT _{1A} receptors Serotonin transporter Central benzodiazepin receptor beta-amyloid plaques 5-HT ₄ receptors Brain CBF Heart flow Cell proliferation Hypoxia Somatostatin receptors Affibody/HER2 ekspression Brain tumors |
|  |   |

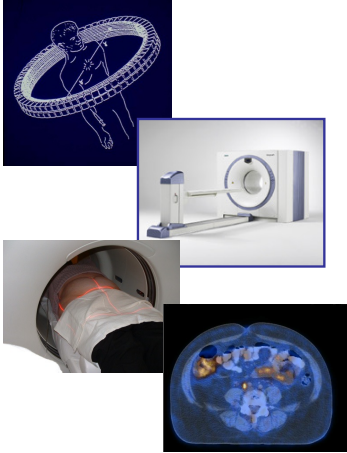
21

| UNIVERSITY OF COPENHAGEN | RIGSHOSPITALET |
|--|----------------|
| <p>Cyklotrons – small 2-3 MeV deuteron-machines ¹⁵O-vand 230 - 400 MeV superconducting magnets for particle-therapy And research in high energy physics (CERN, RIKEN, iThemba).</p> | |
| <p>¹⁸F, ¹¹C, ¹³N og ¹⁵O og ⁶⁴Cu, ⁸⁹Zr, ¹²⁴I. Isotopes for PET-tracers</p> | |
| <ul style="list-style-type: none"> • Increasing demand • Different tracers • Focus on security, GMP, supply chain stability, flexibility, research • Alfa-therapy for theranostics: ligand with Astatin-211 for treatment, Actinium-225 for diagnosis with PET scan | |
| <p>Tak til Holger Jensen</p>   | |

22

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

"PET - The fastest growing medical technology ever "



Positron tracer F-18 FDG

Patient injection

PET scanning combined with CT

Interpretation by NM & radiologist

DTU

RH

High sensitivity and specificity, and game changer for 30 % !

23

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET research



Basic research – cyclotron isotopes, radiochemistry tracers, scanner hardware and new math algorithms

Translational – from lab to clinical patients in animal and man

Clinical research – diagnosis, treatment evaluation, relapse, radiation therapy planning

New isotopes, new tracers, new hardware & software, physiology, patophysiology, new drugs, new methods

- non commercial
- private-public partnership
- industry driven

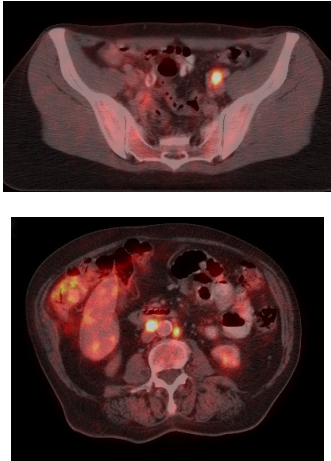
DTU

RH

24

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET/CT in cervical cancer



Metastatic lymph nodes:

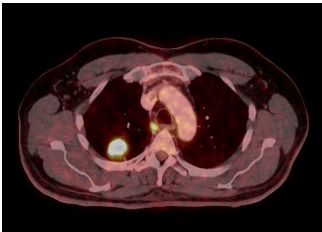
- Pelvis
- Para-aortal
- Inguinal
- Mediastinum
- Neck
- Omentum

DTU RH

25

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET/CT and lung cancer



Preoperative staging of lung cancer with combined PET/CT. Randomized study on PET/CT and lung cancer staging. N= 189, Conventional or same + PET/CT.

Relative risk reduction for a futile thoracotomy 51 %.

DTU RH

Fischer & Højgaard, New Engl J Med 2009;2,361:92-9

26

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

DTU RH

27

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET


External LAP laser system

DTU RH

28

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET/CT for planning of radiation therapy



DTU

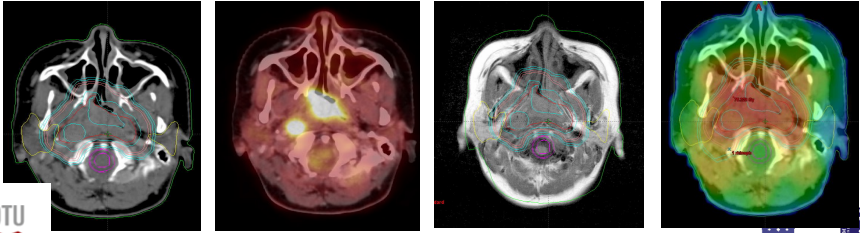
RH

29

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Radiotherapy and imaging

Radiotherapy planned by CT
 If tumor is drawn too small possibilities for cure smaller
 If tumor is drawn too large side-effects worse
 PET and MRI to improve methodology



DTU

FDG-PET


MRI

Treatment plan

RH

30

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET



DTU

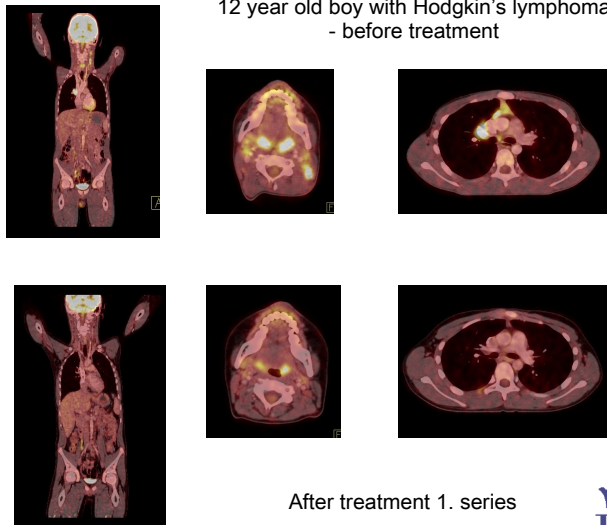
Advance PET scanner 1995

RH

The image shows a large, white PET scanner machine with a patient bed. A small child is sitting on the bed. In the top left corner, there are two small PET scan images of a human torso, one showing a normal scan and the other showing a scan with a dark spot indicating a lesion.

31

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET



DTU

12 year old boy with Hodgkin's lymphoma - before treatment

After treatment 1. series

RH

The image displays a series of PET scans for a 12-year-old boy with Hodgkin's lymphoma. On the left, there are two full-body PET scans. On the right, there are two rows of three scans each: a coronal view, an axial view of the upper chest, and an axial view of the lower chest. The top row is labeled 'before treatment' and shows significant yellow and red areas indicating high metabolic activity (lymphoma). The bottom row is labeled 'After treatment 1. series' and shows a significant reduction in these areas, indicating a positive response to treatment.

32



33



34

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Børneriget – hospital for sick children







UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Movement correction for brain MRI

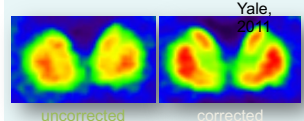
World's first

- Structured light surface scanner with invisible light
- Markerless tracking for MR & PET motion correction

DTU/RH, 2010

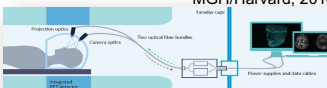


Yale, 2011

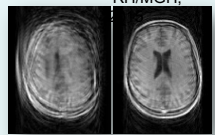


uncorrected corrected

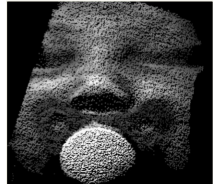
MGH/Harvard, 2014




RH/MGH,




uncorrected corrected



RH, 2015






Oline Vinter Olesen
 PhD, MSc (Eng. Medicine and Technology)
 Founder & CTO, TracInnovations
 Senior Researcher, DTU Compute & RH

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET





Cluster for molecular imaging



Development of new tracers .

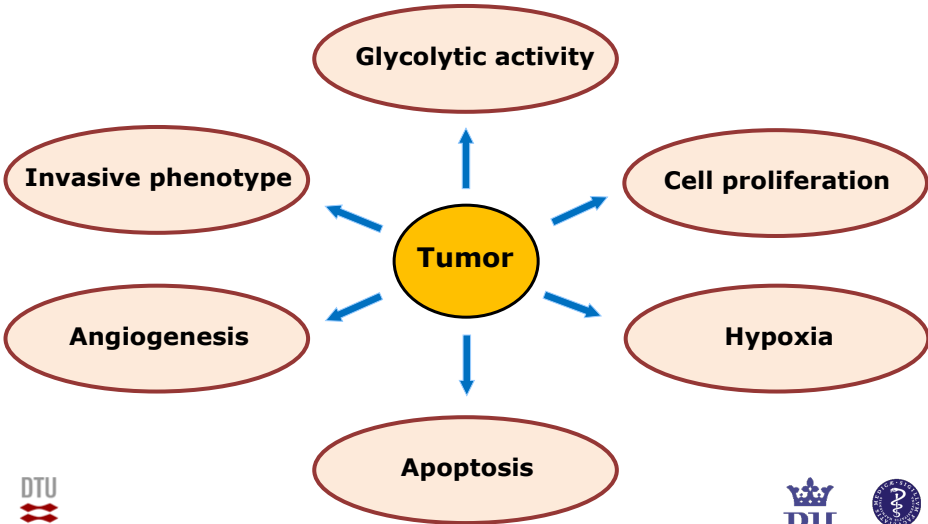
Early evaluation of new drugs for cancer treatment with molecular imaging using animal studies with PET/CT and PET/MR.




Translational from use in animal to man.

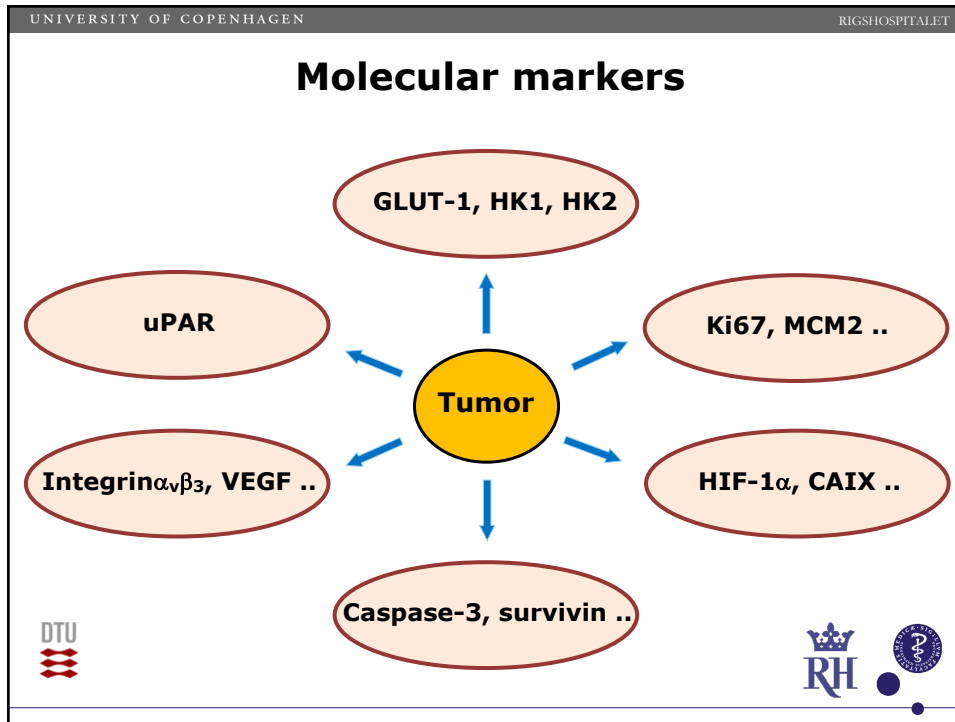





UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

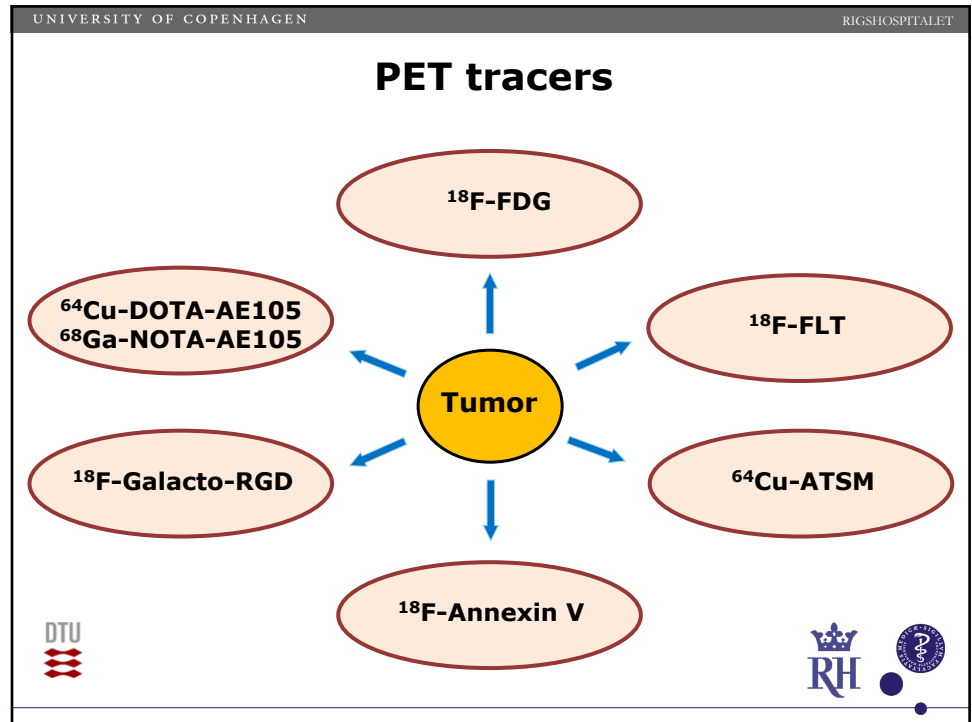
Tissue characteristics





39

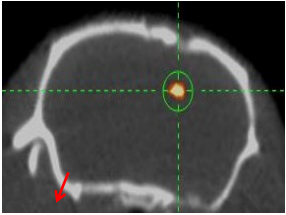



40

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

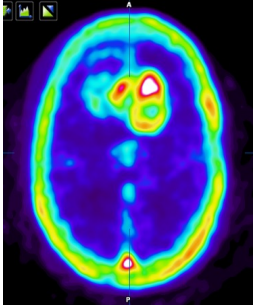
uPAR-PET/MRI of brain cancer – from mouse to man

PDOX GBM

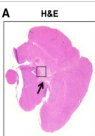
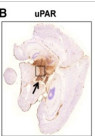
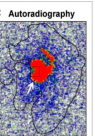










GBM





Ex vivo target validation

| | | |
|---|---|---|
| <p>A H&E</p>  | <p>B uPAR</p>  | <p>C Autoradiography</p>  |
| <div style="text-align: center;"> <p>Normal brain</p>  </div> <div style="text-align: center;"> <p>Cancer cells</p>  </div> | <div style="text-align: center;"> <p>Normal brain</p>  </div> <div style="text-align: center;"> <p>uPAR</p>  </div> |  |

Prof. Andreas Kjaer et al.



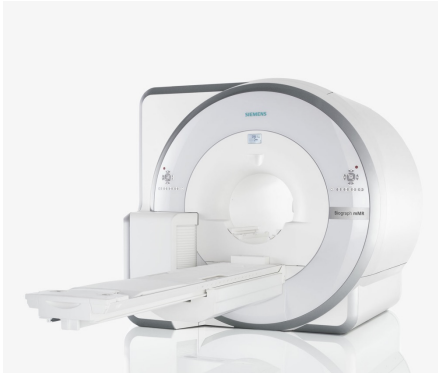




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET



Biograph mMR – the worlds first simultaneous, whole-body molecular MR

Copenhagen PET/MRI

- Simultaneous PET and MRI
- From December 2011

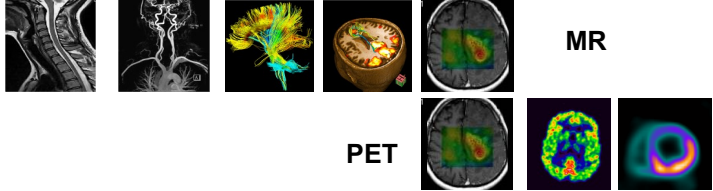




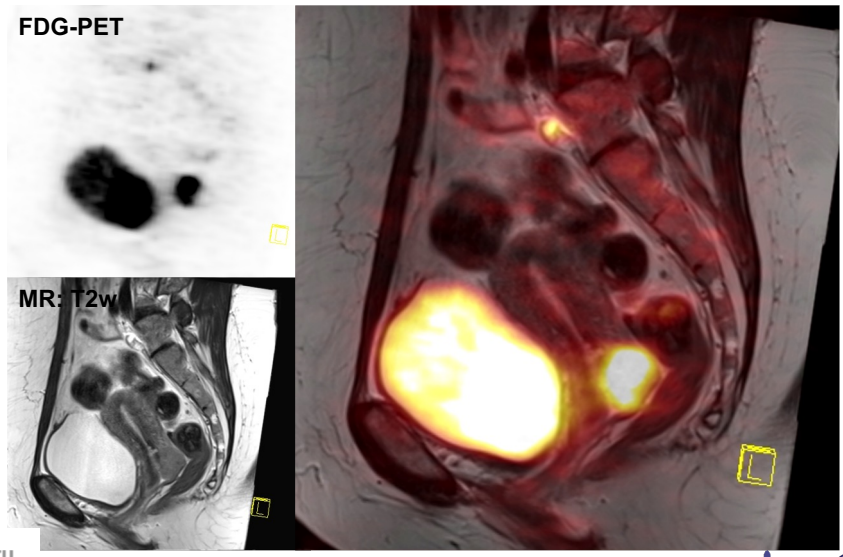
UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Morphology, physiology & molecular imagingin the same scanner ...at the same time



DTU RH

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET




DTU RH


UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET funktion og MR anatomi i columna


MR: T1w



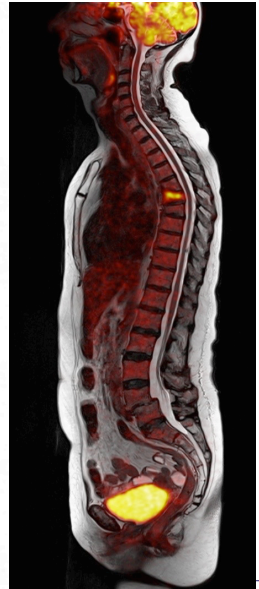
MR: T2w



FDG-PET



PET/MR fusion

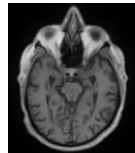


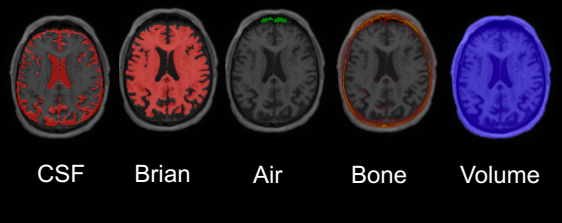
DTU

45

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

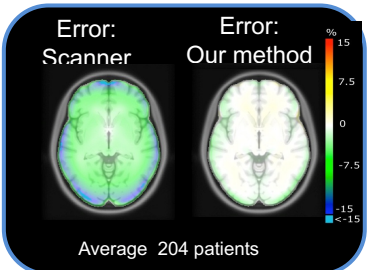
New optimization of PET/MR: RESOLUTE






CSF Brian Air Bone Volume

Error: Scanner Error: Our method




Average 204 patients

New technique for PET/MR adjusts the reconstruction error. Also useable in children. Error now <1 % on PET-signal



Claes Ladefoged, cand.scient., ph.d.-studerende



46

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Multi-center evaluation of 11 PET/MR-correction methods

FDG
A B C D E F
G H I J K

PIB
A B C D E F
G H I J K

Flortetapir
A B C D E F
G H I J K

Rel%
<math><-10</math> -10 -5 0 5 10 >10

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

UNIVERSITY OF COPENHAGEN
FACULTY OF HEALTH SCIENCES

Rigshospitalet

PHD THESIS
CLAES NØHR LAEDØGED

Improvement of quantitative PET/MRI
for better diagnostics in cancer imaging
and neurological diseases


Supervisors:
Professor Liselotte HUYGAARD
Dr Flemming Littrup ANDERSEN

Assessment committee:
Professor Gitte Moon KNUDSEN
Professor Bernhard SATTLER
Dr John Caldwell DICKSON

This thesis has been submitted to the Graduate School
of Health and Medical Sciences, University of Copenhagen, December 2017.


UNIVERSITY OF COPENHAGEN

AI for better imaging

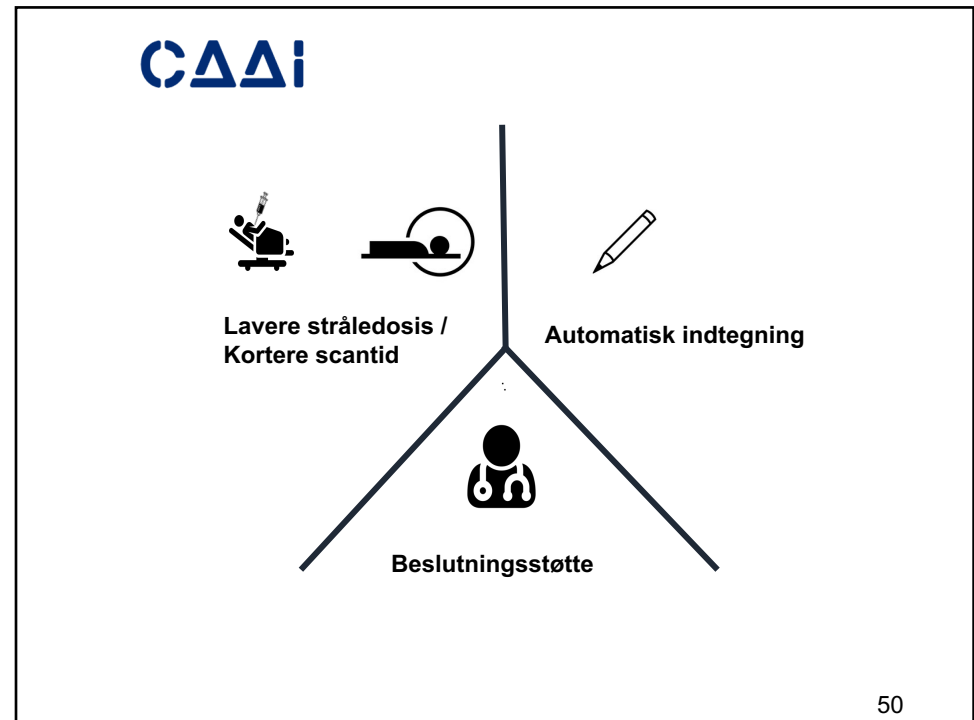


- Better signal to noise ration
- Shorter scan time and reduced dose
- Synthetic data – PET from MRI
- Decision support in MS and dementia
- Analysis and automatic reading ???

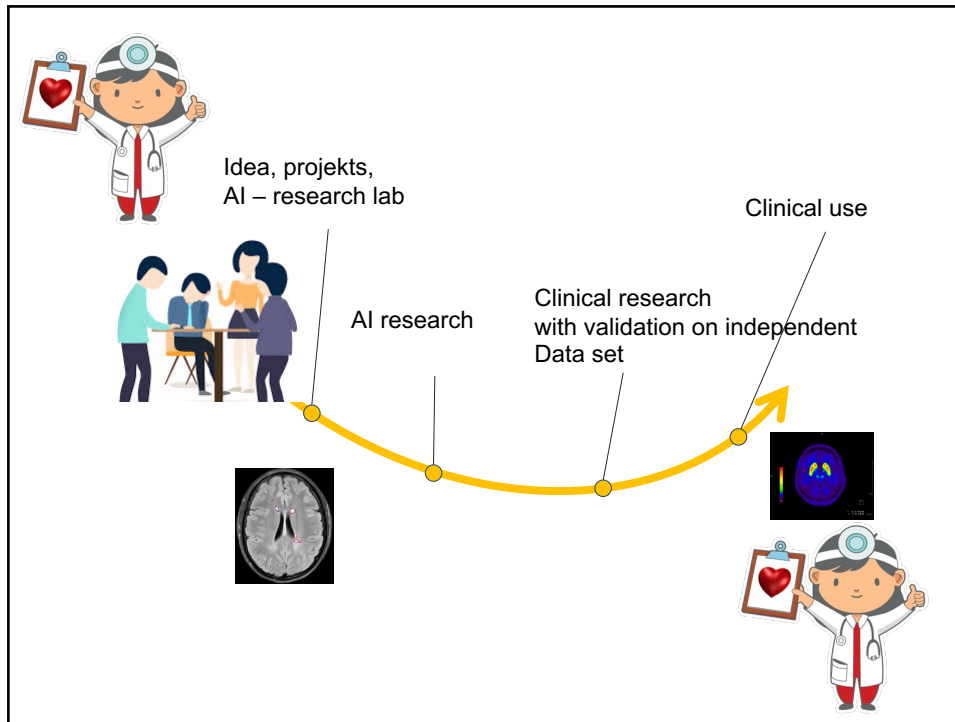
DTU



49



50



51

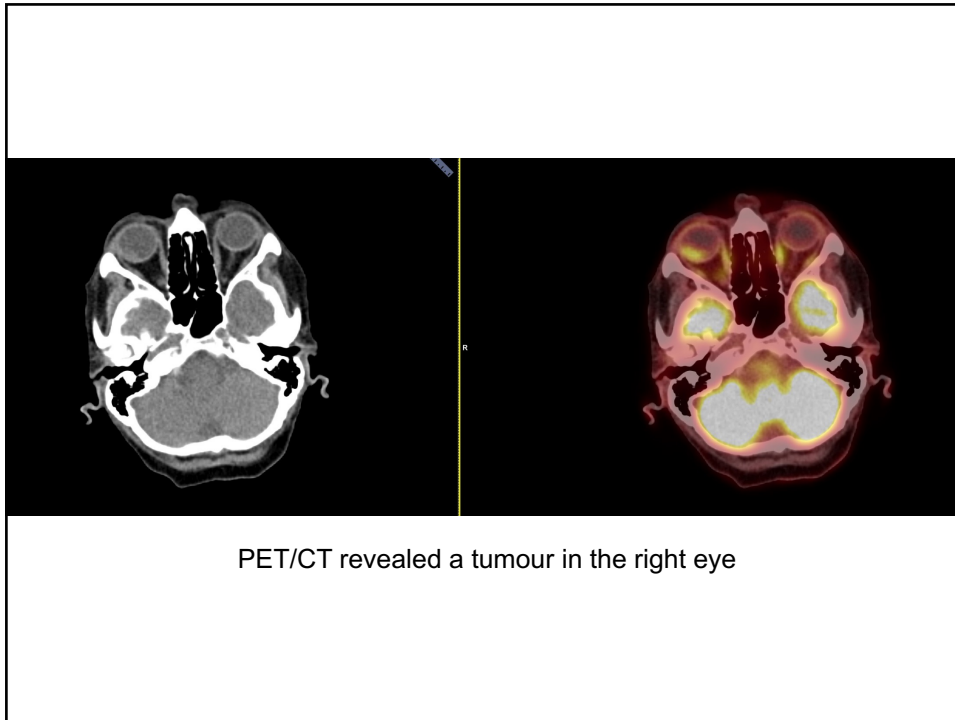
UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Clinical practice brain studies

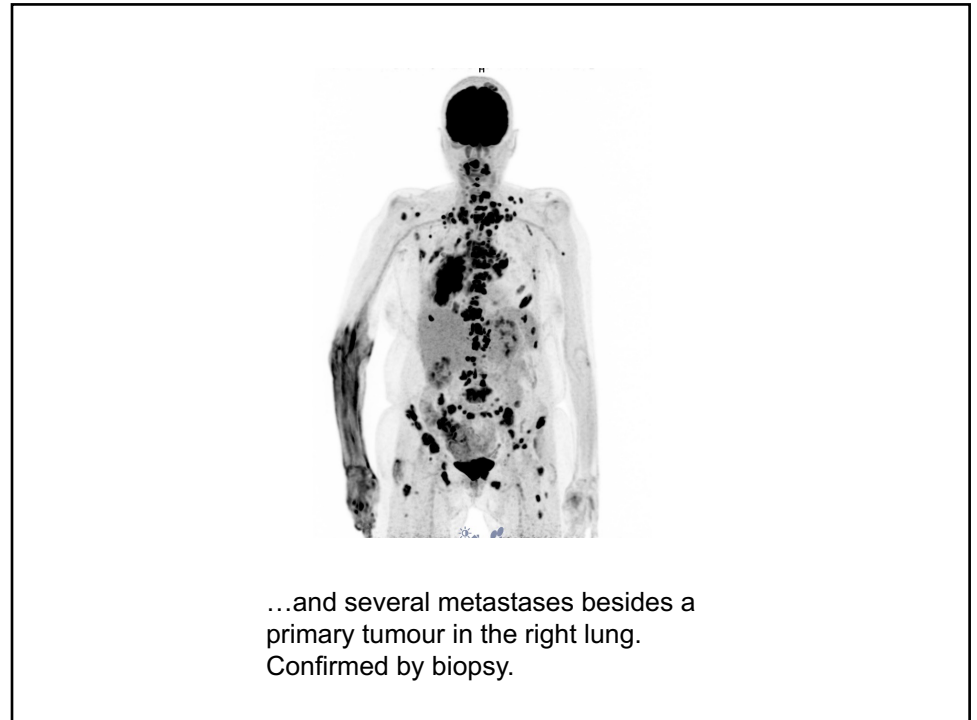
| | | |
|---|--|---|
| <p>T1 MRI</p> <p>Recurrence?</p> | <p>¹⁸F-FE-PE2I DaT PET</p> <p>Healthy</p> | <p>¹⁸F-FDG PET/MR</p> <p>Hippocampal delineation- Anterior to posterior.</p> <p>Hippocampal Volume</p> |
| <p>¹⁸F-FET PET</p> <p>Recurrent Glioblastoma</p> | <p>Parkinson's Disease</p> | <p>Alzheimer's</p> |

Prof. Ian Law

52



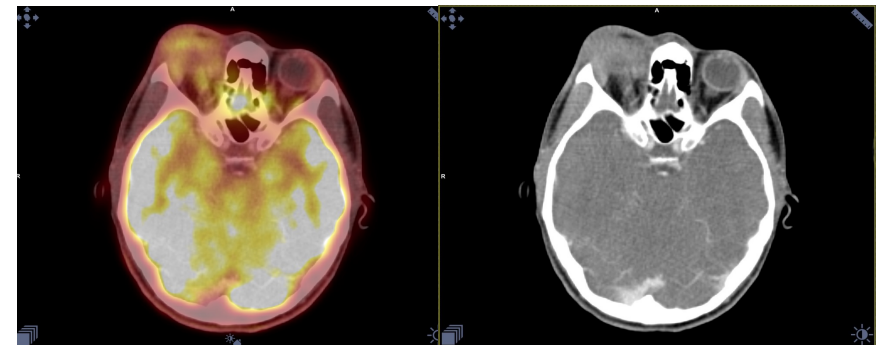
53



54

12 year old boy, previously well, swelling of the right eye. MRI local hospital: proces in right orbita around bulbus.

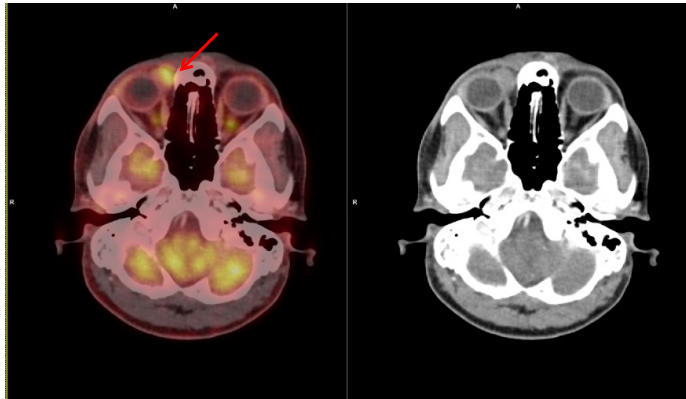
Normal vision. Biopsy: embryonal rhabdomyosarkoma.
WB FDG PET/CT for staging.



PET/CT : Malignant looking proces in right orbita, extra ocular, no bone involvement and no dissemination.

Chemo- og proton therapy in Houston.

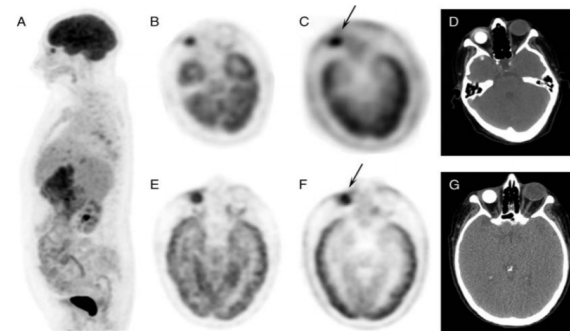
1 year later suspicion of relapse of the rhabdomyosarcoma in the right orbita at control MRI. Referred to WB FDG PET/CT for metabolism in tumor and dissemination ?



Malignant tumor medially in right orbita without signs of dissemination. Chemoterapy, VIT.

57


5
8



58

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

PET/MR and PET/CT and genes and epigenetics and clinical and life style information: "Personalised medicine"



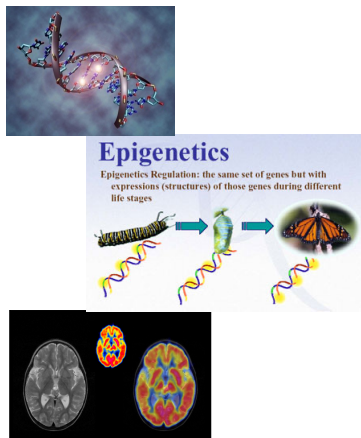
DTU

RH

59

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Personalised Medicine




Epigenetics
Epigenetics Regulation: the same set of genes but with expressions (structures) of those genes during different life stages

Paradigm shift with tailored prevention, early diagnosis, treatment based on genes and epigenetics & The deep phenotype with imaging.

RH


60

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET




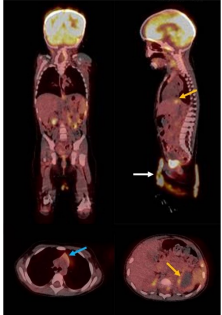

"If this does not help, please come again, and we find something else"

"Couldn't I get the something else right away?"




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

QUADRA Total body PET/CT




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET



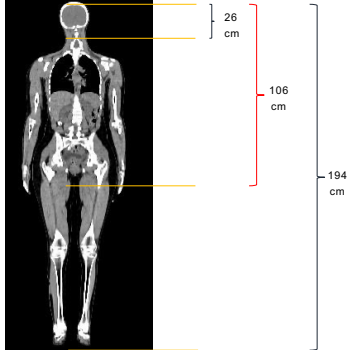
Fast scans with high quality and low dose
– children no sedation.

Long field-of view to physiologi & patophysiologi
with kinetics from dynamic acquisitions - total body
system-physiologi.

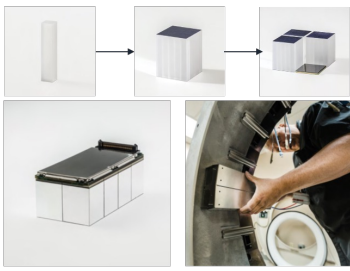
*Deep inspiration breath hold for planning of
radiotherapy.*



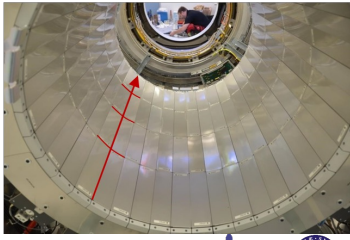

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET



3.2-mm krystal Vision teknologi



Sensitivity:
x 10 standard digital scanner
x 40 analog scanner

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Hodgkin lymfoma, before treatment

After 3 series

The slide displays three PET-CT scans. On the left, two coronal PET-CT scans are shown side-by-side. The first is labeled 'Hodgkin lymfoma, before treatment' and shows significant hypermetabolic activity in the chest and abdomen. The second is labeled 'After 3 series' and shows a marked reduction in this activity. Below these are two axial PET-CT scans of the pelvic region, also showing reduced activity after treatment. To the right is a sagittal CT scan of the same patient, showing the anatomical structures. The logos for the University of Copenhagen and Rigshospitalet are in the bottom right corner.

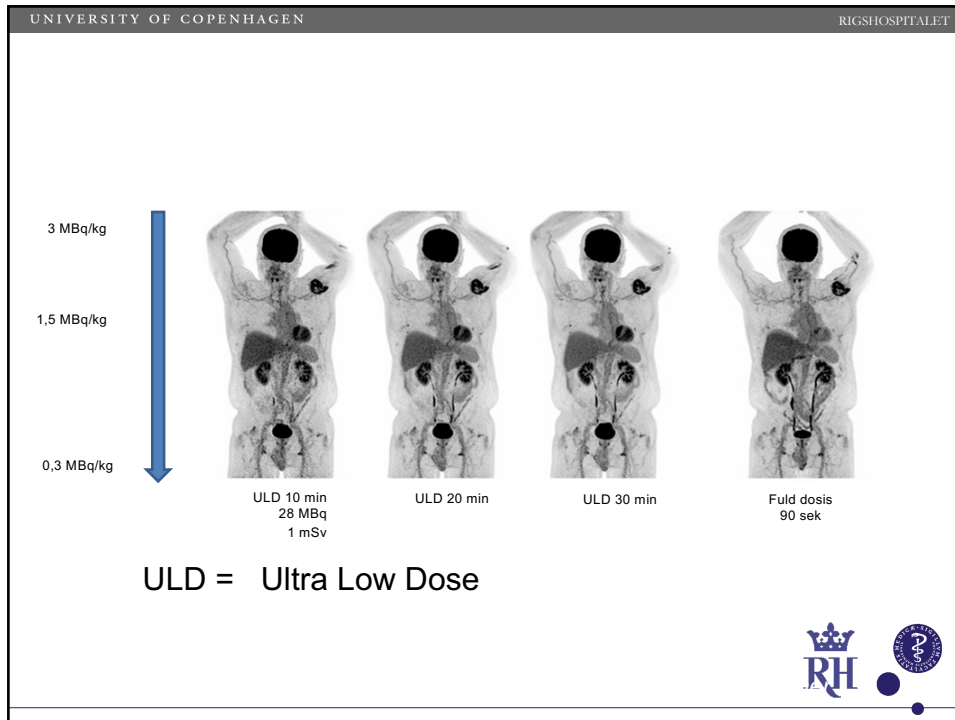
UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Standard 90 sek

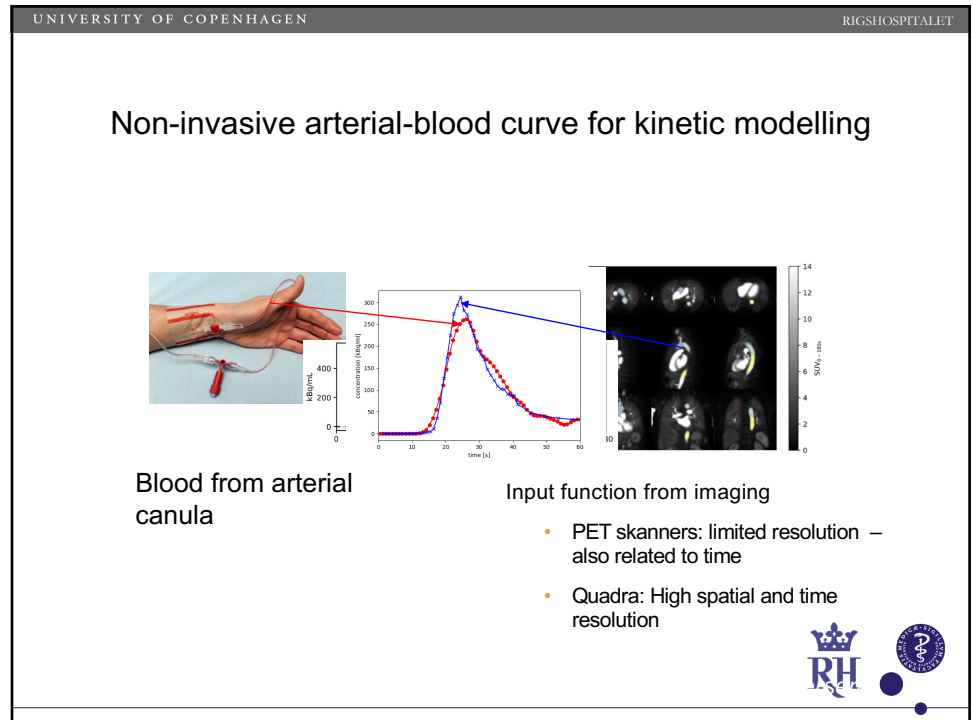
15 sek DIBH

4x15 sek

The slide compares three PET-CT protocols. On the left, a photograph shows a patient lying on the scanner table. In the center, three coronal PET-CT scans are shown side-by-side, labeled 'Standard 90 sek', '15 sek DIBH', and '4x15 sek'. The 'Standard 90 sek' scan shows the most activity, while the '15 sek DIBH' and '4x15 sek' scans show significantly reduced activity. Below these are three axial PET-CT scans corresponding to the same protocols. A small inset shows a sagittal CT scan. The logos for the University of Copenhagen and Rigshospitalet are in the bottom right corner.



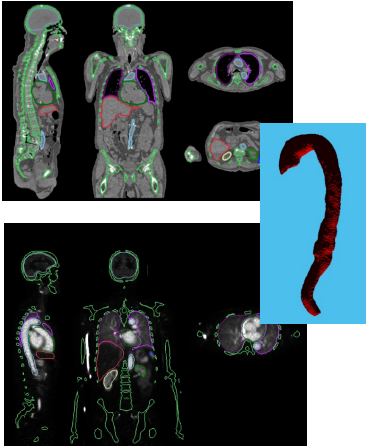
67



68


UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Segmentation and regions of interest



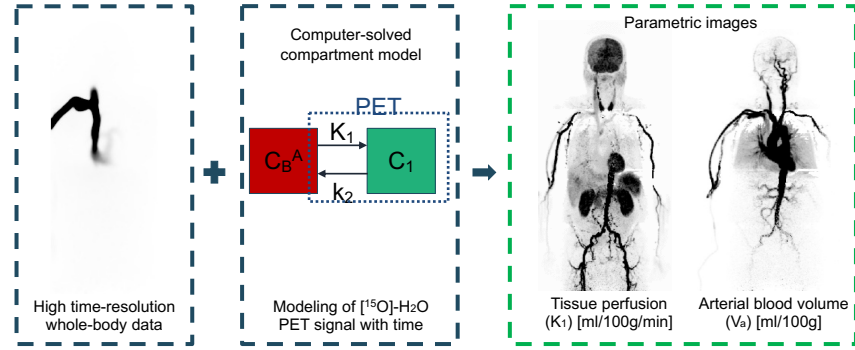
AI-based wholebody segmentation

- Aorta for non-invasive blood concentrations
- Organs
 - Quantitative tissue-time activity curves with high resolution
 - Individual organ modelling



UNIVERSITY OF COPENHAGEN RIGSHOSPITALET


New possibilities – whole-body perfusion with $[^{15}\text{O}]\text{-H}_2\text{O}$



High time-resolution whole-body data + Computer-solved compartment model (PET) → Parametric images

The compartment model shows C_B^A (red box) and C_1 (green box) with forward rate constant K_1 and reverse rate constant k_2 .

Parametric images include: Tissue perfusion (K_1) [ml/100g/min] and Arterial blood volume (V_a) [ml/100g]



UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Decomposition of PET signal – kinetic modelling of [¹⁸F]-FDG

High time-resolution whole-body data

Computer-solved compartment model

PET

Modeling of [¹⁸F]-FDG PET signal with time

Parametric images

| | | | |
|--|---|--|---|
| Net influx rate (K ₁) [ml/100g/min] | Phosphorylation rate (k ₃) [ml/100g/min] | Unidirectional transport of tracer from blood (K ₁) [ml/100g/min] | Vol. of distr. (V _d) [ml/cm ³] |
|--|---|--|---|

71

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

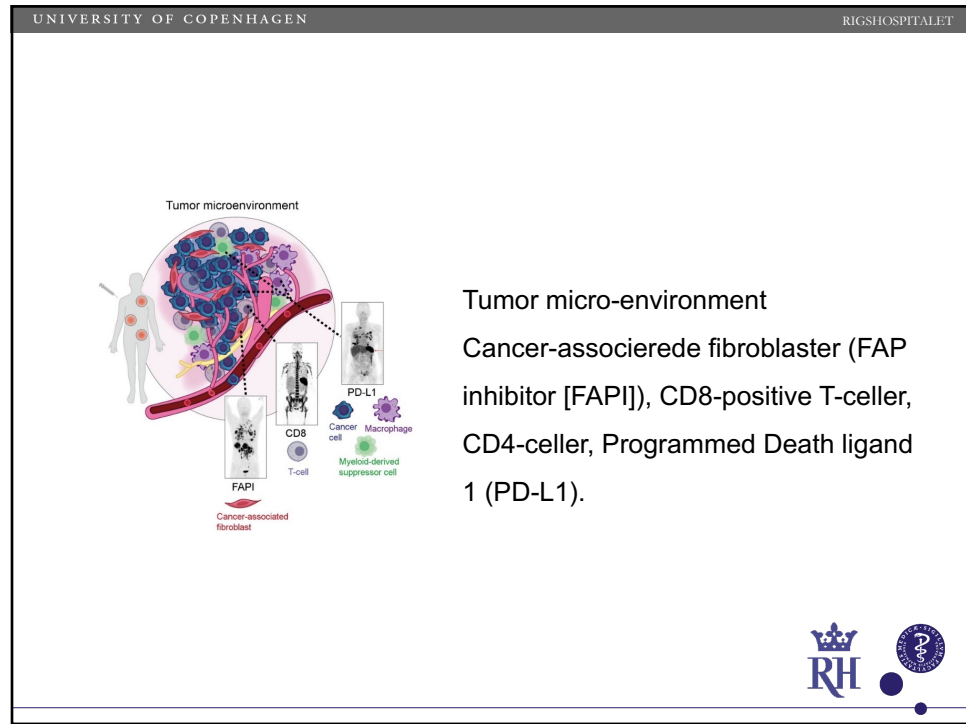
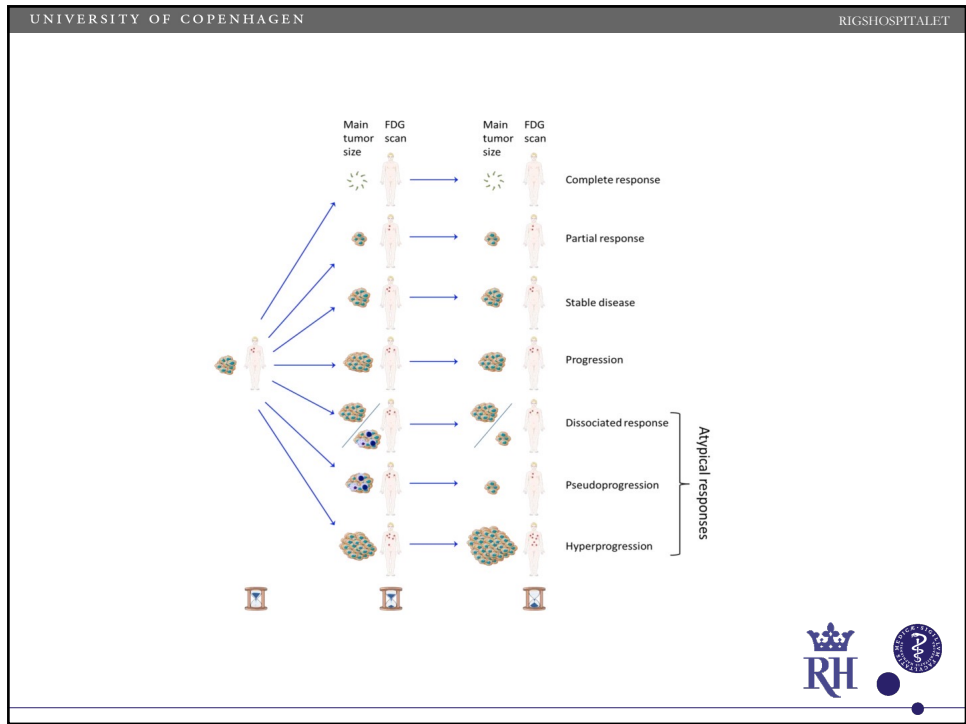
Immun check point inhibitor terapi

Reestablish immune cells' abilities to fight cancer cells - malignant melanoma, NSCLC, bladder.

FDG is taken up by both tumor and immune cells. Specific tracers to activated immune cells.

Few clinical studies and many tracers.

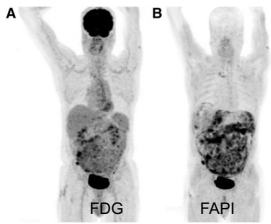
72



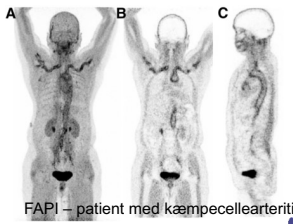
UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

FAPI PET/CT: Will It End the Hegemony of ¹⁸F-FDG in Oncology?


FAPI tracers low uptake in normal tissue and high in cancer.
 FAPI with Ga-68, Cu-64, F-18, Tc-99m and several molecules.
 Signal-noise ration promising for AI solutions.



FDG FAPI



FAPI – patient med kæmpecellearteritis




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Neurodegenerative diseases

Today

Syndromal constructs → Definition → Biological constructs

Clinical testing → Diagnosis → Treatment

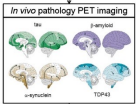


Symptomatic

Future

Biological constructs → Definition → Syndromal constructs

In vivo pathology PET imaging → Diagnosis → Treatment




Etiological

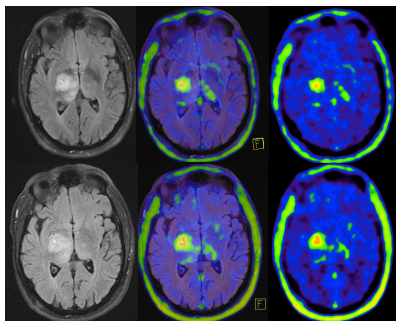
Alzheimer – from syndrom to etiology –
 PET tracers for amyloid, tau etc.

Effective targeted therapy with PET
 as *companion diagnostics*.
 Aducanumab + 14 other drugs coming .

Other neuro-degenerative diseases
 Like PE2i tracer for Parkinson's.



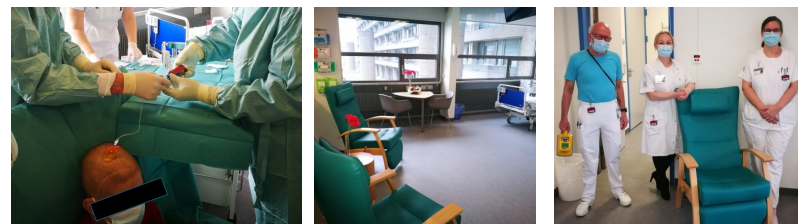
EANM/EANO/RANO practice guidelines/SNMMI procedure standards for imaging of gliomas using PET with radiolabelled amino acids and [^{18}F]FDG.



Children with neuroblastoma in the CNS

Median survival 6 months.

Study MSKCC with Omburtamab median survival first 93 children 47 months.

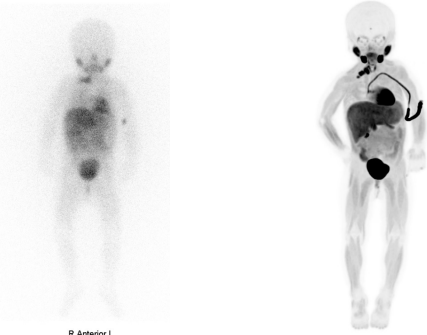


I-131 Omburtamab (monoclonal antibody) in CSF.

Binds to tumor cells behind the intact blood-brain barrier.




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET



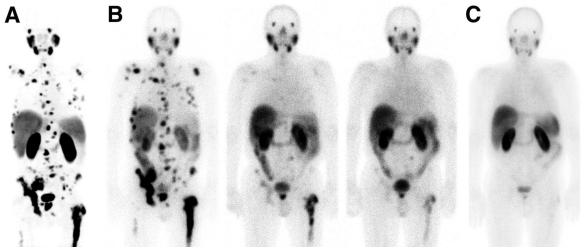
R Anterior L

First MFBG-scan in QUADRA Total Body PET/CT. Girl 16 months with cervical neuroblastoma, 10 min. protokol without sedation or GA, breast feeding and a nap.




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Treatment with PSMA



| 12/2014 | 12/2014 | 02/2015 | 04/2015 | 06/2015 |
|--|---|---|---|---|
| PSA 387.08 ng/mL | PSA 387.08 ng/mL | PSA 9.21 ng/mL | PSA 1.98 ng/mL | PSA 1.08 ng/mL |
| 150 MBq ⁶⁸ Ca-PSMA11 PET/CT (MIP) 1 h p.i. | 6 GBq ¹⁷⁷ Lu-PSMA617 Planar scan (GM) 20 h p.i. | 6 GBq ¹⁷⁷ Lu-PSMA617 Planar scan (GM) 20 h p.i. | 6 GBq ¹⁷⁷ Lu-PSMA617 Planar scan (GM) 20 h p.i. | 700 MBq ^{111m} Tc-MIP1427 Planar scan (GM) 3 h p.i. |

PSMA-Targeted Radionuclide Therapy of Metastatic Castration-Resistant Prostate Cancer with ¹⁷⁷Lu-Labeled PSMA-617



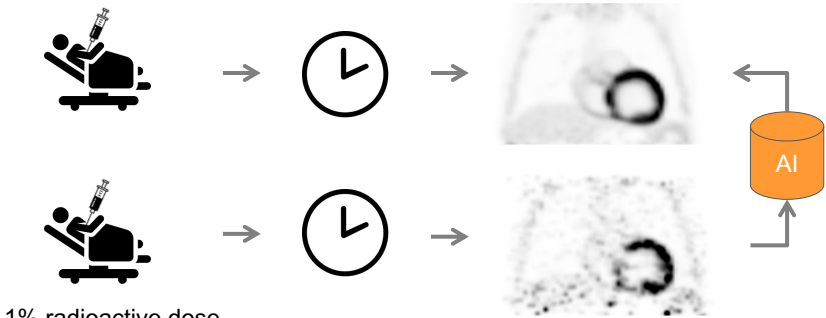
UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

The future – AI for imaging




UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Low radiation dose



1% radioactive dose



UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

SNMMI SmartBrief

News for nuclear medicine and molecular imaging professionals SIGN UP · SHARE

TOP STORY

Deep learning may be used for PET image noise reduction

A study in *Physics in Medicine & Biology* found the use of deep learning noise-reduction technology led to F-18 FDG dose reduction in cardiac PET images for patients with ischemic heart disease, without losing diagnostic accuracy. "A reduction to one hundredth of the dose is possible with quantitative clinical metrics comparable to that obtained with a full dose," researchers wrote. **Full Story:** [Physics World](#) (3/1)

Ladefoged et al, *Phys Med Biol* 2021 66(5), 054003

UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

Ekspert

AI model

AI for Automatic analysis

ORIGINAL ARTICLE


Assessment of Artificial Intelligence Automatic Multiple Sclerosis Lesion Delineation Tool for Clinical Use

Amalie Monberg Hindsholm¹ · Stig Præstekjær Cramer¹ · Helle Juhl Simonsen¹ · Jette Laurup Frederiksen¹ · Flemming Andersen¹ · Liselotte Højgaard¹ · Claes Nahr Ladefoged¹ · Ulrich Lindberg¹

Received: 2 June 2021 / Accepted: 16 August 2021
© The Author(s) 2021


UNIVERSITY OF COPENHAGEN RIGSHOSPITALET

The futuristic perspective



All persons have their own digital twin in the "sky", and have annual US/PET/CT/MR + blood tests with "genomics" and other "omics", epigenetics "liquid biopsy" for tumor cell-DNA.

AI compares results with the digital twin in the sky from last year, and Suggests a treatment plan with personalized medicine.



REGION H Rigshospitalet




Leg lokkede den lille kræftpatient ind i MR-scanneren

Liselotte Højgaard, klinikchef, professor, dr.med., Lise Borgwardt, overlæge, ph.d. og overlæge Helle Hjorth Johannesen, Klinik for Klinisk Fysiologi, Nuklearmedicin og PET, Rigshospitalet

I foråret 2019 havde vi på Rigshospitalet en lille patient; en meget syg dreng på 4 år. Han var tidligere rask, men havde udviklet en stor kræftsvulst i venstre lunge. Så stor, at hjertet, der normalt sidder i venstre side, var skubbet helt over i højre side og op mod halsen.

sien ikke bedøve drengen – de mente at han ville kunne gå til, hvis han blev lagt ned og kom i narkose/tik noget at sove på. Og uden billeder kunne operationen ikke laves. Så alle stod med ryggen mod muren.

Drengen var meget fornuftig og havde fanta-

