


Statistical Signal Processing of Nuclear Medicine Images

– Extraction of Spatio-temporal Blood Information –


Mika Naganawa
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Positron Emission Tomography


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- Tomographic image of a distribution of radioactive pharmaceutical.
 - Functional imaging.



PET

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Cases using FDG


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- ¹⁸F-FDG (fluorodeoxyglucose).
 - Detecting abnormalities of metabolism.

Alzheimer's disease


Cocaine addiction

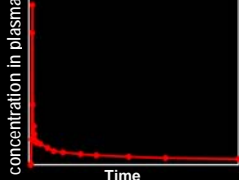
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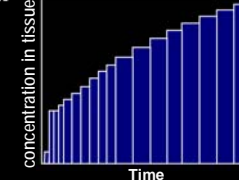
Kinetic Analysis of Dynamic PET Images

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pTAC
(Plasma Time Activity Curve)



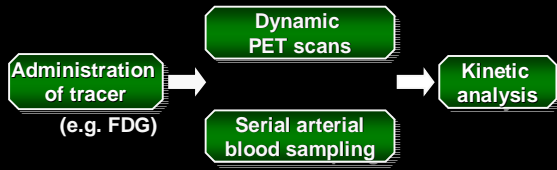
tTAC
(Tissue Time Activity Curve)

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Protocol for Kinetic Analysis

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Our Goal

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- Serial arterial blood sampling.
 - Time-consuming protocol, painful.
 - Catheter inserted into a radial artery.



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What is Blood Volume? 7/14

capillary
brain tissue
voxel
microvessel

Blood volume image [%]

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Data Representation (Spatial ICA) 8/14

Dynamic PET image matrix
Mixing matrix
Source matrix

voxel
time

pTAC
tTAC

pTAC map (= Blood volume image)
tTAC map

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Application of conventional ICA 9/14

- FastICA [Hyvärinen, 1995].
- Cost function: kurtosis.

concentration [Bq/mL] $\times 10^4$

time [min]

True pTAC
ICA-estimated pTAC

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EPICA (Extraction of the pTAC using ICA) 10/14

Appending negative images
Standardization

negative images

Time integration values

$\times (-1)$

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Design of a Cost Function 11/14

number of voxels

voxel value

$\lambda = 50, k = 0.3$

$$G(z) = z^6 - \frac{\lambda}{k} \exp\left(-\frac{|z|}{k}\right)$$

Penalty term

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Estimated pTACs 12/14

Serial arterial blood sampling
• 24 samples

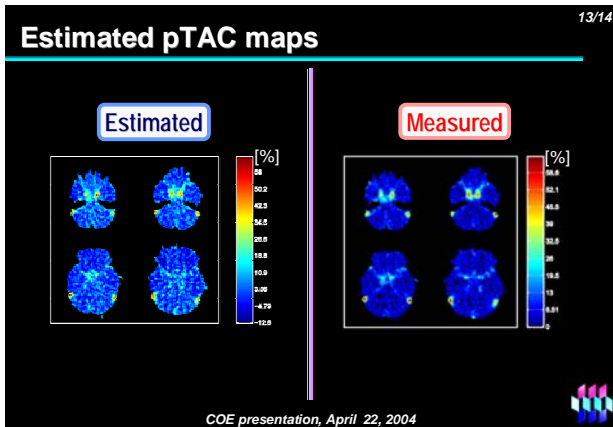
^{18}F -FDG PET measurement
• 27 frames and 30 slices

○ : measured arterial blood samples
— : estimated (EPICA, $\lambda=50, k=0.3$)

True [mg/min/100g]

EPICA [mg/min/100g]

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Conclusion

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- We proposed the method for extracting the pTAC from dynamic brain PET images.
 - EPICA.
- The estimated pTAC by EPICA was comparable to the measured pTAC.

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