

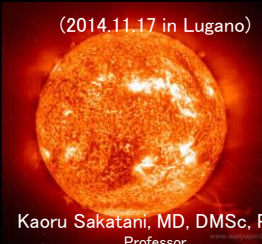
Zurich 大学附属循環器センター (Fondazione Cardiocentro Ticino : <http://www.cardiocentro.org/>) におけるセミナー  
CPR における NIRS による脳循環モニターなどについて紹介しましたが、Aur icchio 教授をはじめスタッフの皆さんは NIRS に大変興味をもたれました。



セミナー後の記念撮影 (左端は Aur icchio 教授)



Near infrared spectroscopy (NIRS)  
 - Basic principle and clinical application -  
 (2014.11.17 in Lugano)

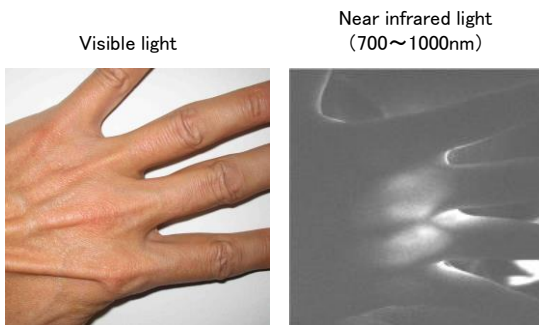


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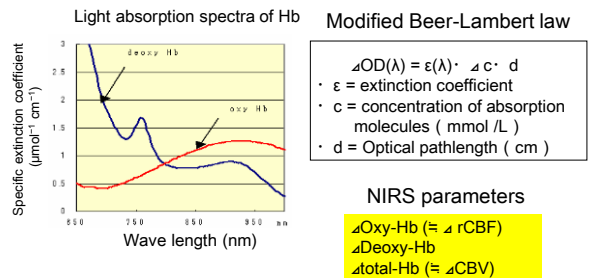
## Summary

- (A) Basic principle of NIRS
- (B) NIRS monitoring of CBF changes
- (C) Clinical application of NIRS:
  - ① Evaluation method of autoregulation
  - ② NIRS monitoring during chest compressions
  - ③ Functional study using NIRS

## Basic principle of NIRS (1)



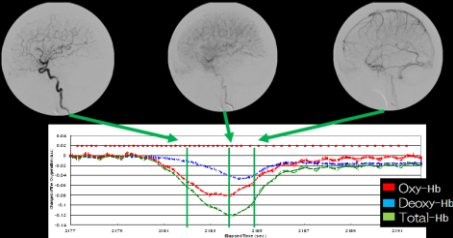
## Basic principle of NIRS (2)



NIRS is an optical method for measuring changes of cerebral blood oxygenation by means of the characteristic absorption spectra of hemoglobin in the near infrared range and the modified Beer-Lambert law. NIRS allows to measure concentration changes in Oxy-Hb ( $\approx \Delta rCBF$ ), Deoxy-Hb, and total-Hb ( $\approx \Delta CBV$ )

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Which vascular compartments (i.e., arteries, capillaries, veins) NIRS measurement is sensitive?



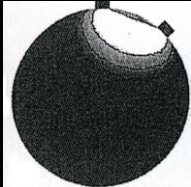
In order to examine this issue, NIRS measurement was performed during cerebral angiography. After injection of the contrast medium into the ICA, Hb concentration decreased; the maximum decrease of Hb was observed during the capillary and venous phases, suggesting that NIRS measured CBO changes mainly in capillary and venous compartments.

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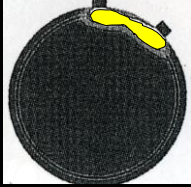
The depth of NIRS measurement areas

Effect of CSF in subarachnoid space

CSF ( - ) :  
 traditional ways of thought.



CSF ( + )



( Okada & Delpy 2003 )

## NIRS system

2Ch-NIRS



NIRO-200  
(Hamamatsu Photonics)

Setting of probes



NIRS parameters

- $\Delta$ oxy-Hb ( $\approx$  CBF)
- $\Delta$ deoxy-Hb
- $\Delta$ total Hb ( $\approx$  CBV)
- rSO<sub>2</sub>

## Bed-side monitoring of cerebral blood flow

TCD and NIRS allows non-invasive and real-time measurements

	TCD	NIRS
Methods of measurements	Ultrasound Doppler effects	NIR light Absorption spectrum
Measuring object	Blood velocity	Hb oxygenation
Technique of measurement	Need experience	Easy (need experience for data analysis)

## NIRS can measure regardless of ages

Neonates



Adults

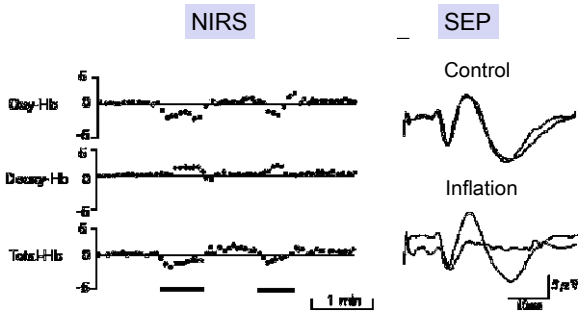


Aged people



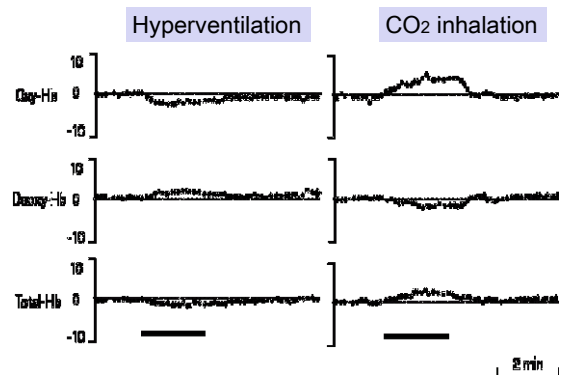
## NIRS monitoring of CBF changes

### 1. Changes of CBO and SEP during Balloon Matas test



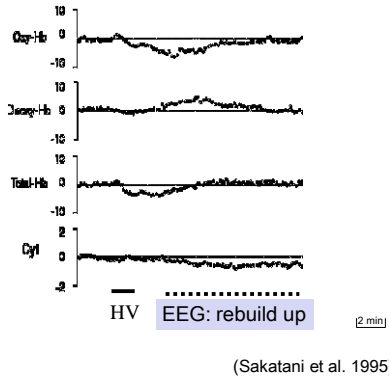
(Sakatani et al. 1995)

### 2. CO<sub>2</sub> responses

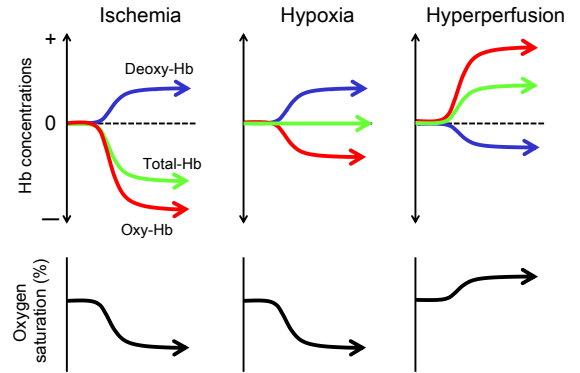


(Sakatani et al. 1995)

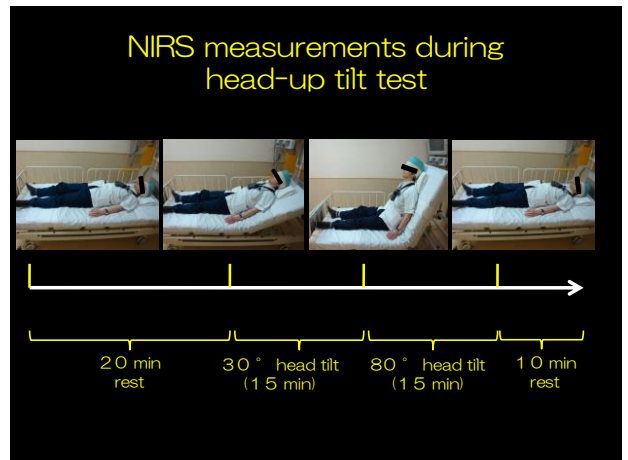
### 3. Effects of hyperventilation on CBO in Moya-Moya disease



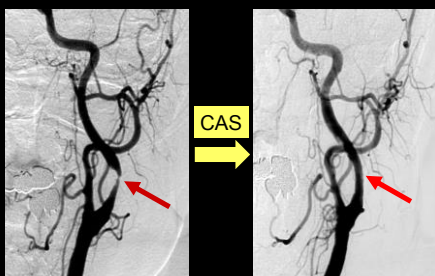
### Relation between NIRS parameter changes and hemodynamic patterns



### Evaluation method of autoregulation of CBF using NIRS

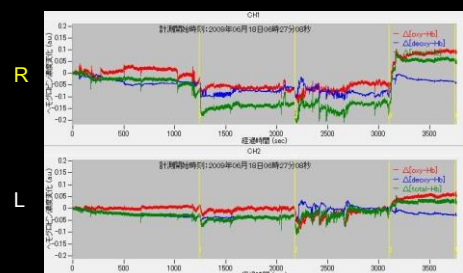


### Effect of CAS (carotid artery stenting) on autoregulation in cerebral ischemia



### Rt-ICA stenosis (8.8%) (Before operation)

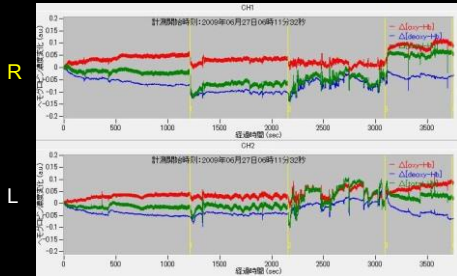
The patient was lightheaded before surgery



Note: systemic blood pressure did not change during head-up tilt test

## 1 week after CAS

The patient did not feel dizziness 1 week after surgery



## Detection of ROSC in patients with cardiac arrest during chest compressions using NIRS

(ROSC: return of spontaneous circulation)



ISOTT2014 in London

### Background:

In general, return of spontaneous circulation (ROSC) during chest compressions has been detected by palpation of arterial pulse and monitoring end-tidal CO<sub>2</sub>; however, it is necessary to stop chest compressions during palpation of pulse, and to intubate for monitoring end-tidal CO<sub>2</sub>.

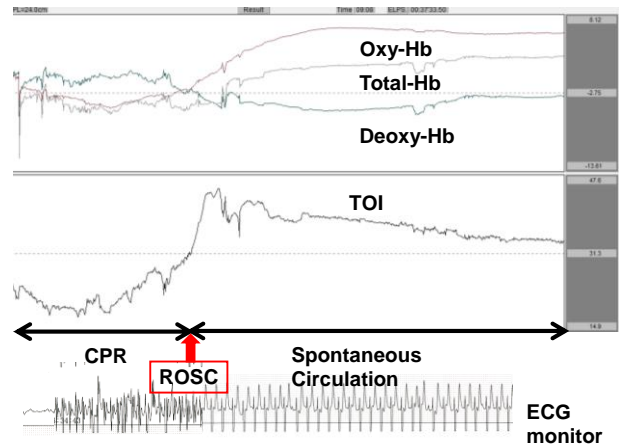
In the present study, we evaluated whether NIRS allows us to detect ROSC during chest compressions without interruption of chest compressions.

### Methods:

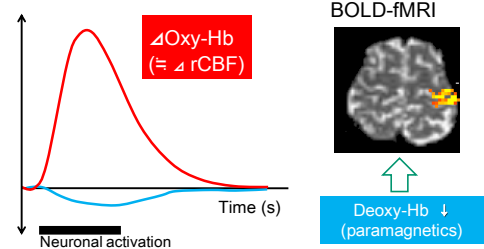
We evaluated 16 patients with cardiac arrest [age 58.2±14.2, male sex 15 patients] using NIRS (NIRO-200NX, Hamamatsu Photonics, Japan).

### Results:

We found cerebral blood flow waveform in synchrony with chest compressions in all patients. In addition, we observed abrupt increases of oxy-hemoglobin concentration and tissue oxygen index (TOI), which was associated with ROSC detected by palpation of pulse.

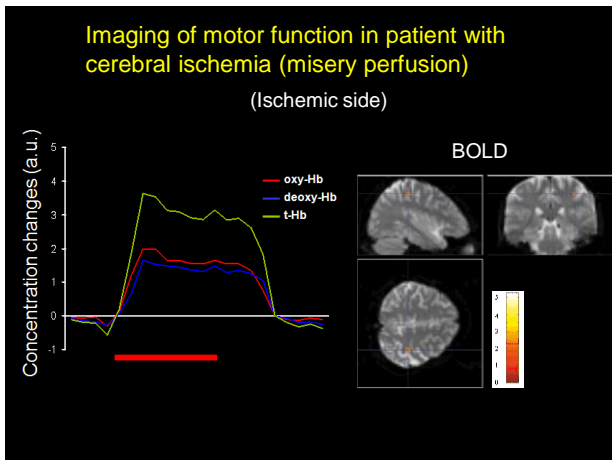
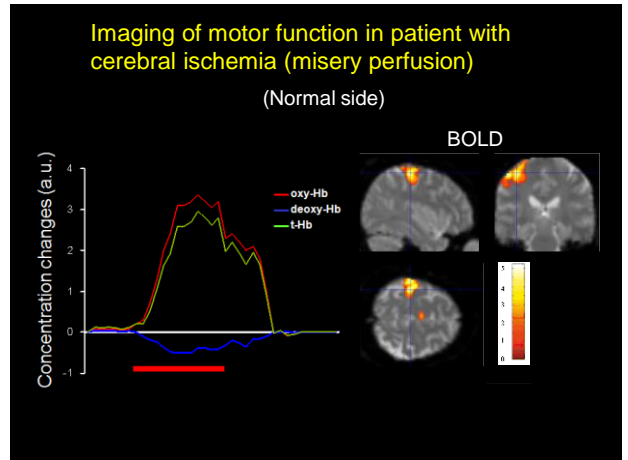
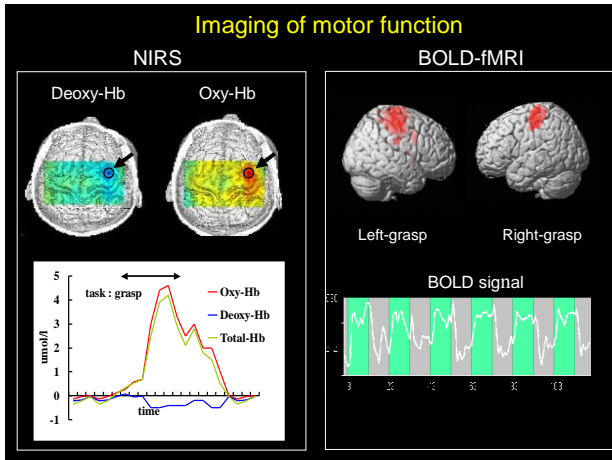


## CBO changes during neuronal activation



## Functional study using NIRS

NIRS demonstrates an increase of Oxy-Hb during activation. The Oxy-Hb changes reflect neuronal activation since changes in Oxy-Hb correlate with changes in rCBF. Neuronal activation decreases Deoxy-H, which causes an increase of BOLD signal. NIRS thus provides more information about the evoked-CBO changes than does BOLD-fMRI, although the spatial resolution of NIRS is poor due to light scattering within the tissues.



## Summary

- NIRS allows non-invasive and real-time monitoring of CBF changes by measuring Hb oxygenation changes.
- NIRS can measure CBF changes regardless of ages.
- NIRS is applicable to CBF monitoring in patients with various heart diseases and CNS diseases.
- NIRS can measure brain function.

