Oxygen Monitoring: Brain vs Fingertip (or Tissue)?

(Narcotic-Induced Respiratory Depression)

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No relevant commercial affiliations

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(Tissue NIRS in assessment and management of critically ill patients)

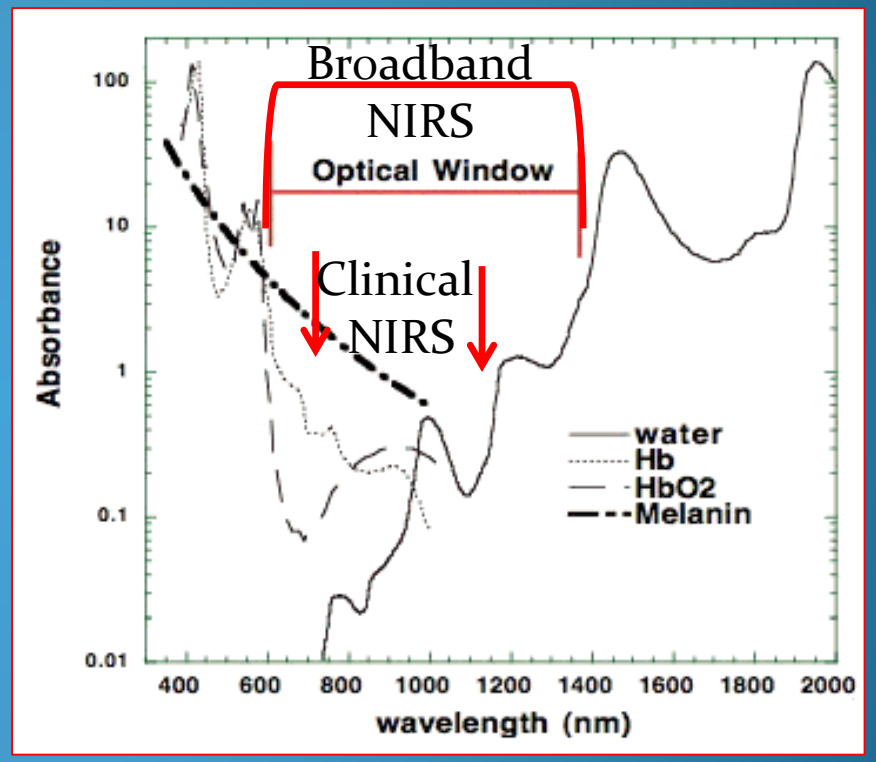
NIR Spectroscopy

Water highly absorptive except within range 600-1350 nm "optical window"

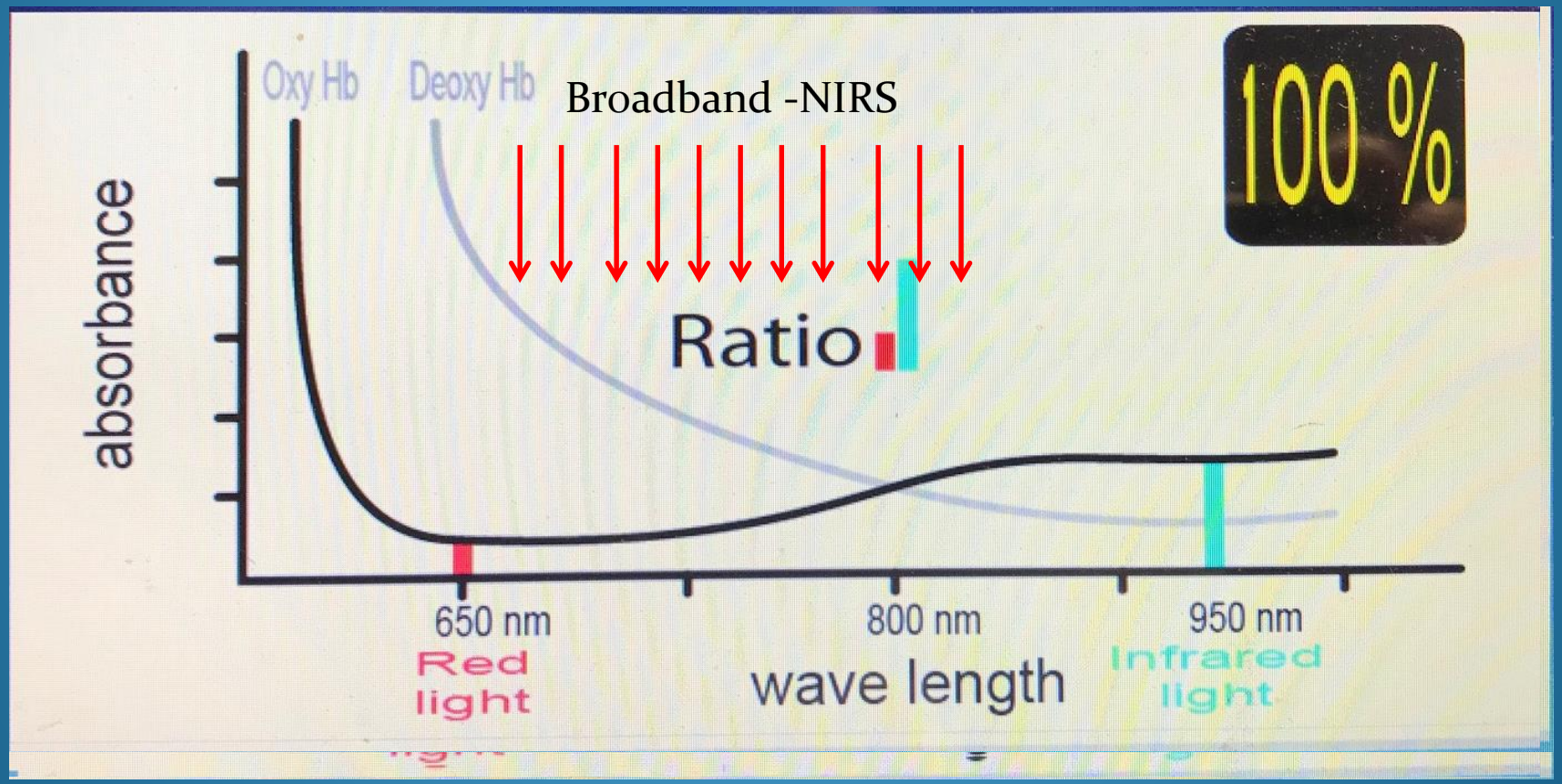
Facilitates measurement of key species of HbO2 and oxidative metabolism

Conventional NIRS: 2-4 wavelengths

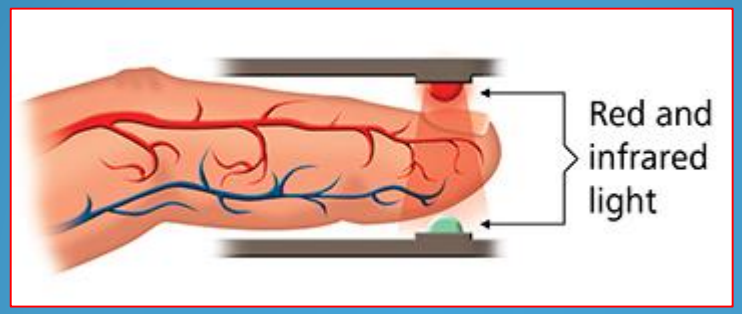
Broadband NIRS: multi wavelengths



NIRS hemoglobin O2 saturation: differential absorption of various wavelengths between oxygenated and deoxygenated Hemoglobin



Pulse oximetry: O2 substrate delivery



Concerns:

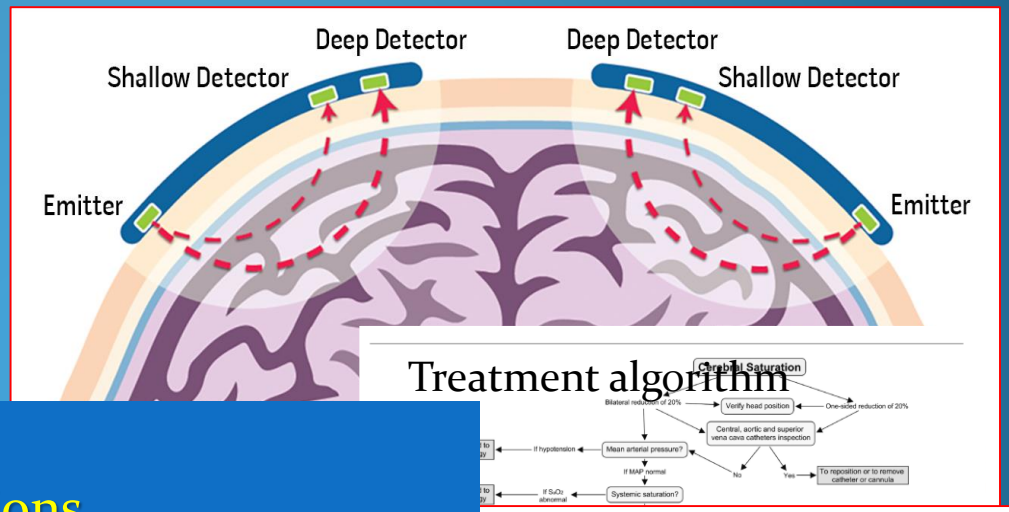
malposition
motion artifact
peripheral v/c (cold, ischemia)
ambient light

→ 'alarm fatigue'

'Change' in absorptance = arterial saturation

Tissue oximetry: delivery/metabolism

Cerebral NIRS



Treatment algorithm

Sensitive to global ischemic events
Amenable to physiologic interventions

BUT

Variable extracerebral contamination (5-15%)

Analysis algorithm assumes fixed arterial/venous partitioning (30%/70% - change with ischemia/$PaCO_2$)

Measures very small sample frontal cortex (1cc)

n High-Risk Cardiac Surgery

uture, MD,* Antoine Rochon, MD,*

Assessing Regional
ation Frequency During
and Responsiveness to an

n, BS,†‡ Maria Fritock, MD,§ Rebecca Y. Klinger, MD,‖
lie Huffmyer, MD,** Michelle Parish, BSN,††
Gayane Yenokyan, PhD,‡‡ and Charles W. Hogue, MD††

Cerebral NIRS: new developments-

Photo-acoustic coupling

Intraoperative Cerebral Autoregulation Assessment Using Ultrasound-Tagged Near-Infrared-Based Cerebral Blood Flow in Comparison to Transcranial Doppler Cerebral Flow Velocity: A Pilot Study

John M. Murkin, MD, FRCPC,* Moshe Kamar, MD,† Zmira Silman, MSc,† Michal Balberg, PhD,† and Sandra J. Adams, RN*

Objective: This was a pilot study comparing the ability of a new ultrasound-tagged near-infrared (UT-NIR) device to detect cerebral autoregulation (CA) in comparison to transcranial Doppler (TCD).

Design: An unblinded, prospective, clinical feasibility study.

Setting: Tertiary-care university hospital cardiac surgical operating rooms.

Participants: Twenty adult patients undergoing cardiac surgery with cardiopulmonary bypass (CPB).

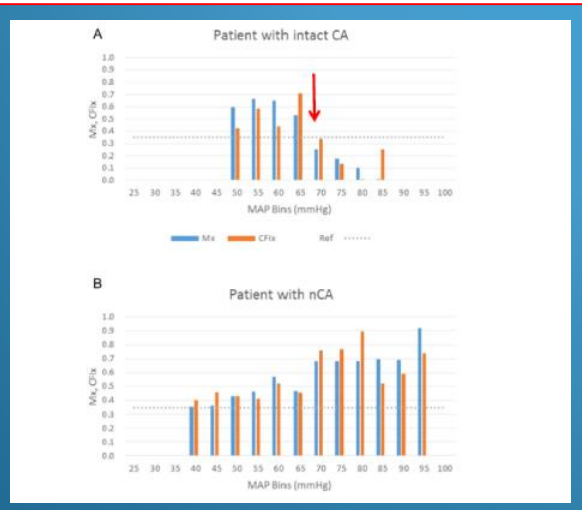
Interventions: There were no clinical interventions based on study monitoring devices, but a continuous correlation analysis of digital data from transcranial Doppler (TCD) velocity was compared with a novel UT-NIR device and correlation analysis of change signals versus mean arterial pressure was performed in order to detect presence or absence of intact CA and for determination of the lower limit of cerebral autoregulation during CPB.

Measurements and Main Results: Similar and highly significant concordance ($\kappa = 1.00$; $p < 0.001$) was demonstrated between the 2 methodologies for determination of CA, indicating good correlation between the 2 methodologies. Intact CA was absent in 2 patients during CPB, and both devices were able to detect this.

Conclusions: To the authors' knowledge this is the first clinical report of a UT-NIR device that shows promise as a clinically useful modality for detection of CA and the lower limit of cerebral autoregulation. The utility of UT-NIR was demonstrated further during times at which extensive usage of electrocautery or functional absence of the transcranial window rendered TCD uninterpretable.

KEY WORDS: *cerebral blood flow, CBF, transcranial Doppler, TCD, ultrasound-tagged near-infrared device, UT-NIR, cardiopulmonary bypass, CPB, cerebral autoregulation*

U/S focus beam
'tags' photons at depth
Discriminates deep cerebral tissue

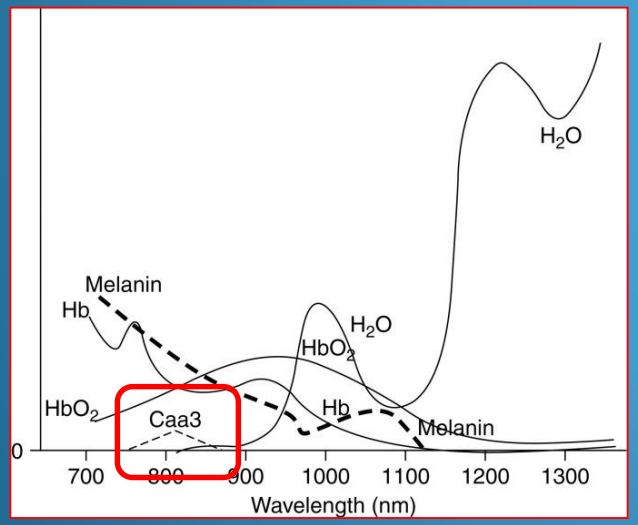


"UT-NIRS detects presence/impairment of cerebral autoregulation""

Broadband-NIRS:
Cytochromeaa3 - measurement of energy substrates

Continuous monitoring CBF and CMRO2

Detect onset ischemia



Biomedical Optics EXPRESS

Development of a combined broadband near-infrared and diffusion correlation system for monitoring cerebral blood flow and oxidative metabolism in preterm infants

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[2]Imaging Division, Lawson Health Research Institute, London, ON, Canada
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Abstract: Neonatal neuromonitoring is a major clinical focus of near-infrared spectroscopy (NIRS) and there is an increasing interest in measuring cerebral blood flow (CBF) and oxidative metabolism ($CMRO_2$) in addition to the classic tissue oxygenation saturation (StO_2). The purpose of this study was to assess the ability of broadband NIRS combined with diffusion correlation spectroscopy (DCS) to measured changes in StO_2, CBF and $CMRO_2$ in preterm infants undergoing pharmaceutical treatment of patent ductus arteriosus. CBF was measured by both DCS and contrast-enhanced NIRS for comparison. No significant difference in the treatment-induced CBF decrease was found between DCS (27.9 ± 2.2%) and NIRS (26.5 ± 4.3%). A reduction in StO_2 (70.5 ± 2.4% to 63.7 ± 2.9%) was measured by broadband NIRS, reflecting the increase in oxygen extraction required to maintain $CMRO_2$. This study demonstrates the applicability of broadband NIRS combined with DCS for neuromonitoring in this patient population.

OCIS codes: (170.3660) Light propagation in tissues; (170.3880) Medical and biological imaging; (170.6510) Spectroscopy, tissue diagnostics.

Tissue oximetry

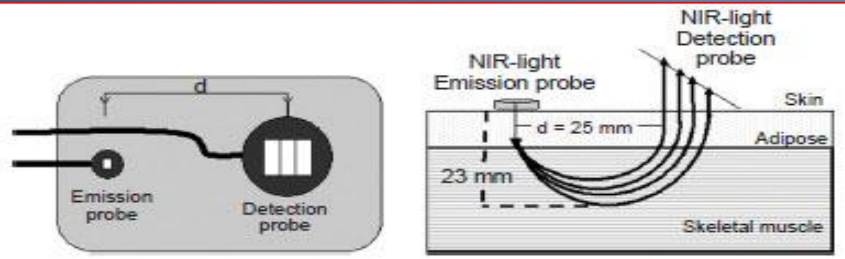

Figure 1- Diagram of a distal tip of the NIRS optical cable (A). With 25 mm spacing (d) between emission and detection probes, approximately 95% of the detected optical signal is from 23 mm of tissue penetration (B). Note the curved shape of the light path (banana shape).

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Soft tissue oxygenation and risk of mortality (STORM): An early marker of critical illness?

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mission but was the only independent predictor of mortality (adjusted odds ratio, 1.06; 95% confidence interval, 1.01-1.12; $P = .04$).

Conclusions: Tissue oxygen saturation may identify critical illness in patients who would not traditionally meet ICU admission criteria and thus may identify patients who benefit from closer monito

Initial Soft Tissue Oxygenation is Associated with Prolonged ICU Admission

Of 126 consecutive consenting adult patients admitted to ICU:

Primary Diagnosis	
cardiogenic shock (n= 31)	mortality 9/31
hemorrhagic shock (n= 5)	mortality 1/5
neurogenic shock (n=1)	mortality 0
respiratory failure (n= 44)	mortality 10/44
septic shock (n= 45)	mortality 19/45

- Initial ICU StO_2 strongly correlated with prolonged ICU admission (>3 d)
- Serial StO_2 trend with prolonged hospitalization (>10d)

Narcotic-Induced Respiratory Depression

Oxygen supplementation

Conversion tables

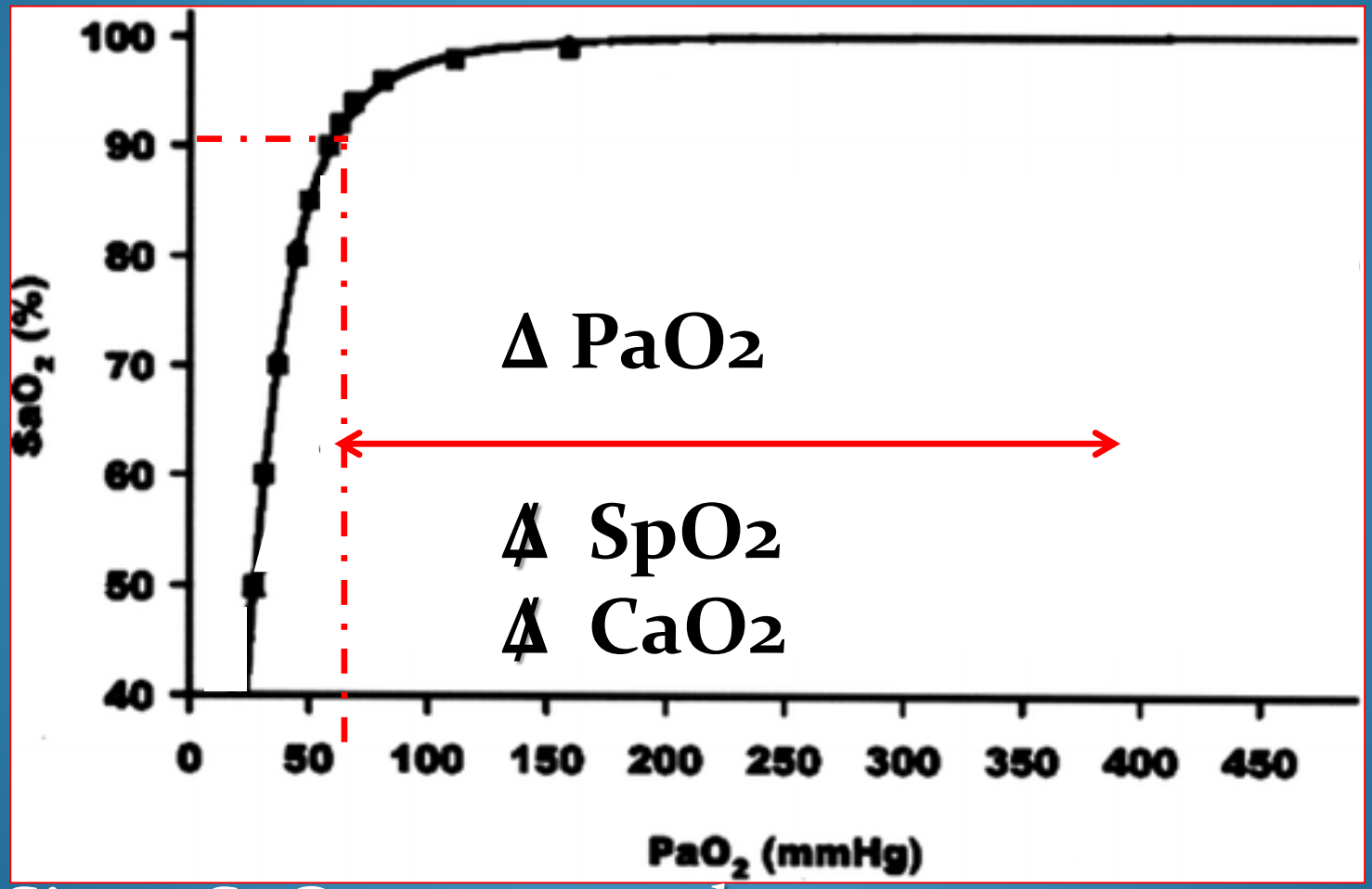
1 Estimating PaO_2 from a given SO_2

SO_2 (%)	PaO_2 (mmHg)
80	44
81	45
82	46
83	47
84	49
85	50
86	52
87	53
88	55
89	57
90	60
91	62
92	65
93	69
94	73
95	79
96	86

2 Estimating FiO_2

Method	O_2 flow (l/min)	Estimated FIO2 (%)
Nasal cannula	1	24
	2	28
	3	32
	4	36
	5-6	50
	7-8	60
Face mask with reservoir	6	60
	7	70
	8	80
	9	90
	10	96

Decrease in SpO2 is a late indicator of hypoxemia



Since ScO2 preserved:

SpO2, ScO2, StO2 all decrease late

Oxygen supplementation

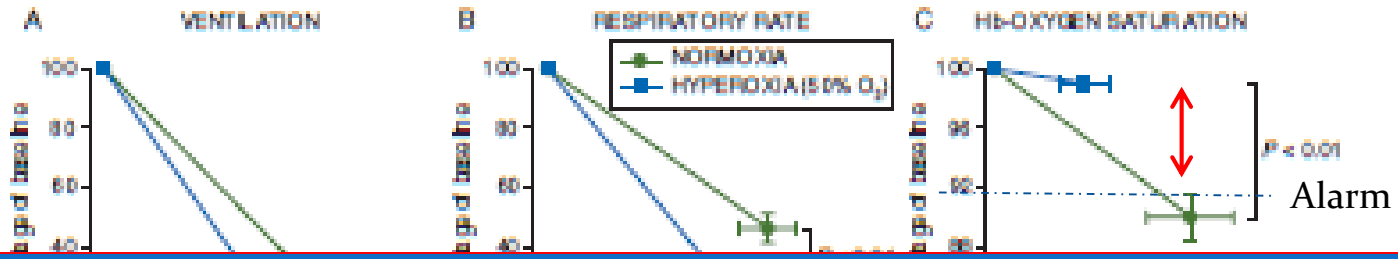
British Journal of Anaesthesia 110 (5): 837–41 (2013)
Advance Access publication 4 January 2013 · doi:10.1093/bja/aes494

BJA

RESPIRATION AND THE AIRWAY

High-inspired oxygen concentration further impairs

20 healthy volunteers
50 ug remifentanil
FiO_2 0.21 vs 0.5



O_2 supplementation can delay SpO_2 desaturation by several minutes

Hyperoxia decreases peripheral (~80%) and central (~20%) chemoceptor activity (exacerbates apnea since decrease CO_2 responsivity)

$PaCO_2$ increases 3-4 mmHg/min ($\Delta PaCO_2 = 10 \rightarrow \Delta pH = 0.08$)

4 min → pH ≈ ↓7. 28

Acidosis, non-invasive ventilation and mortality in hospitalised COPD exacerbations

C M Roberts,[1,2] R A Stone,[1,3] R J Buckingham,[1] N A Pursey,[1] D Lowe,[1] On behalf of the National Chronic Obstructive Pulmonary Disease Resources and Outcomes Project (NCROP) implementation group

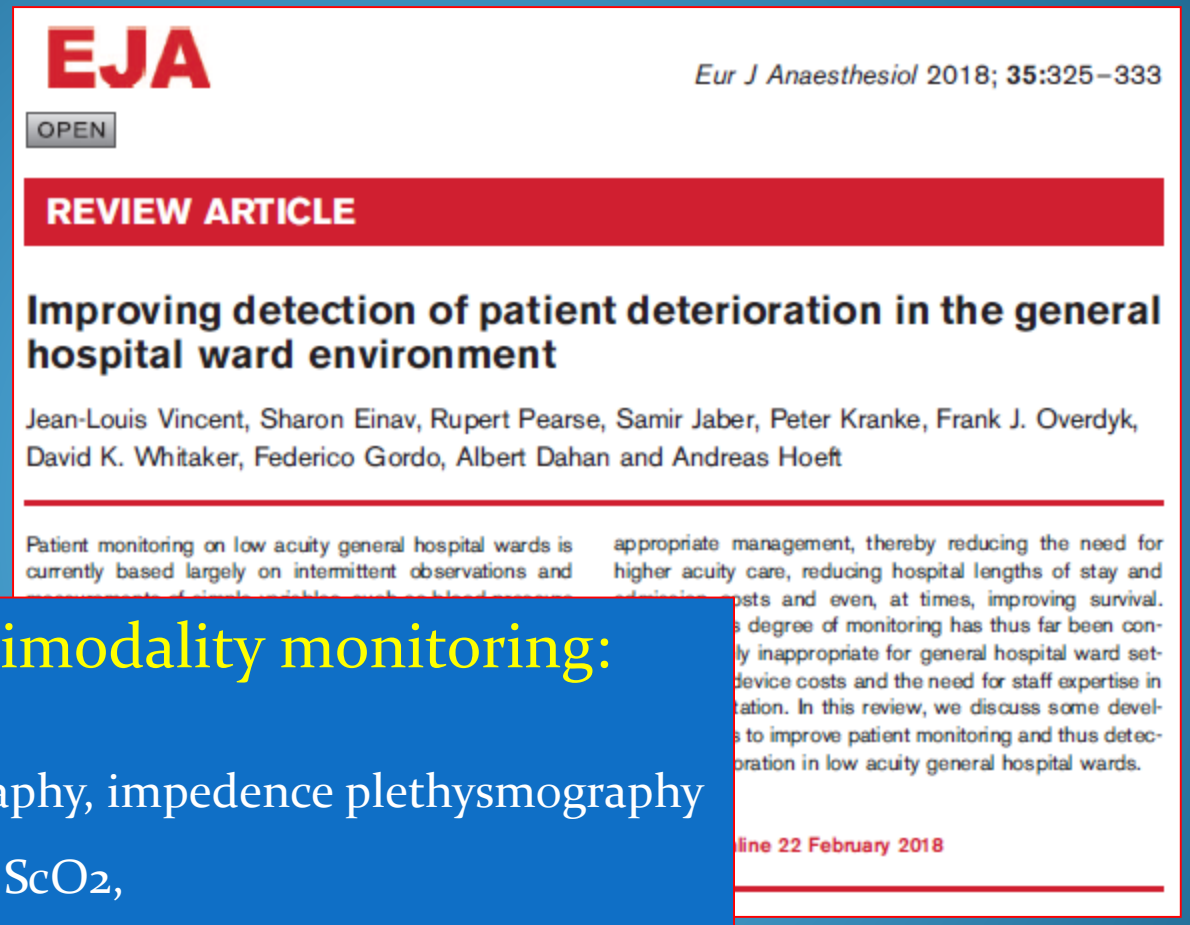
Thorax 2011;**66**:43–48. doi:10.1136/thx.2010.153114

Table 4 Mortality

	Inpatient mortality:				
	For ALL Patients not receiving NIV		For ALL Patients receiving NIV		Fishers Exact test (NIV versus not NIV
	%	N	%	N	
ALL PATIENTS	5	475/8639	25	270/1077	<0.001
Acidotic patients	14	165/1174	26	249/969	<0.001
Non-acidotic patients	4	246/5994	10	8/78	0.02

Narcotic-Induced Respiratory Depression

?



EJA

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Eur J Anaesthesiol 2018; **35**:325–333

REVIEW ARTICLE

Improving detection of patient deterioration in the general hospital ward environment

Jean-Louis Vincent, Sharon Einav, Rupert Pearse, Samir Jaber, Peter Kranke, Frank J. Overdyk, David K. Whitaker, Federico Gordo, Albert Dahan and Andreas Hoeft

Patient monitoring on low acuity general hospital wards is currently based largely on intermittent observations and

appropriate management, thereby reducing the need for higher acuity care, reducing hospital lengths of stay and osts and even, at times, improving survival. s degree of monitoring has thus far been con- ly inappropriate for general hospital ward set- device costs and the need for staff expertise in tation. In this review, we discuss some devel- s to improve patient monitoring and thus detec- oration in low acuity general hospital wards.

line 22 February 2018

Integrated multimodality monitoring:

Ventilation: capnography, impedence plethysmography

Oxygenation: SpO_2, ScO_2,

Hemodynamics: HR,