CONSORCI
HOSPITAL GENERAL
UNIVERSITARI
VALÈNCIA

TEMA DE REPASO:

Monitorización de la función neurológica.

Indicaciones en quirófano y en UCC, como se utilizan, como interpretarlos.

Dra Eva Mateo. Dra Itziar De la Cruz. SARTD CHGUV.

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Consorcio Hospital General Universitario de Valencia

SARTD-CHGUV Sesión de Formación Continuada
Valencia 21 de Enero de 2014

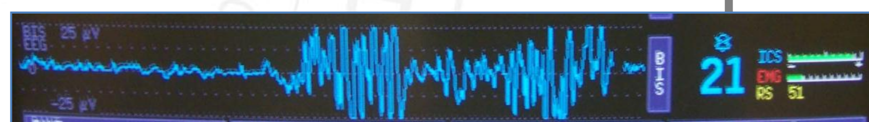
- El rápido reconocimiento de una alteración fisiológica (**monitorización**) alerta al clínico que el paciente se está deteriorando, pero este hecho solo beneficia al paciente si existe un **tratamiento efectivo**. Y aunque éste exista sólo tendrá valor si se aplica de forma **rápida**.

- Revisión de la Cochrane sobre la pulsioximetría (21773 pacientes): detecta hipoxemia, pero con nivel de evidencia bajo sobre su efecto sobre la morbilidad y mortalidad perioperatoria.

Br J Anaesth 2006; 97: 1-3
Br J Anaesth 2006; 97: 39-45
Br J Anaesth 2006; 97: 64-8

- 1. Flujo sanguineo cerebral (FSC)
  - Doppler Transcraneal
- 2. Metabolismo cerebral
  - Sat regional de oxígeno (SrO2)
    - INVOS / Equanox

- 3. EEG y derivados



BIS/Sedline

1. Flujo sanguineo cerebral

Doppler Transcraneal

2. Sat regional de oxígeno

INVOS / Equanox

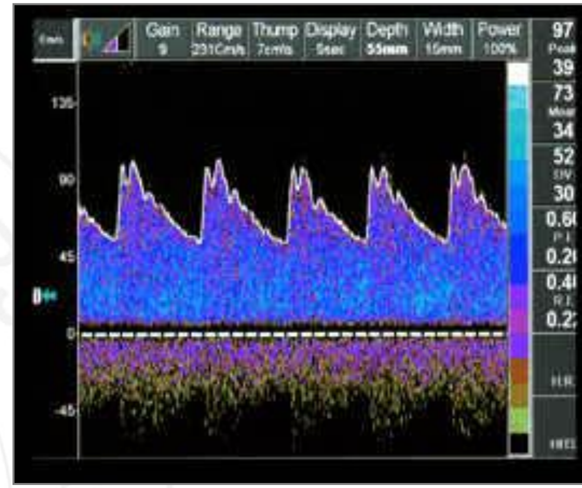
3. EEG y derivados.

BIS/Sedline

1. Flujo sanguineo cerebral

Doppler Transcraneal:

- Determina la velocidad de flujo de la arteria insonada
- La velocidad de la sangre aumenta en sístole y disminuye en diástole
- Refleja la PPC. La v. diastólica disminuye a medida que la PPC disminuye
- Indicaciones:
  - Cirugía de carótida
  - HSA (control del vasoespasmo)
  - Seguimiento TCE
  - Muerte Cerebral



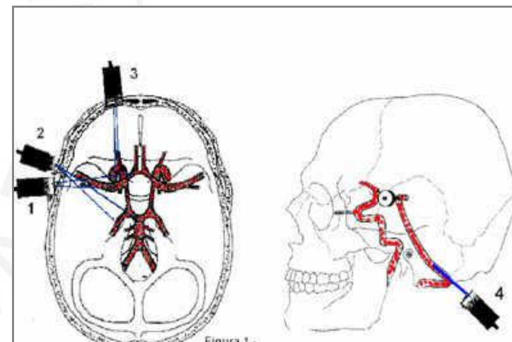


Figura 1.-
1 Ventana transtemporal para ACM y ACA
2 Ventana transtemporal insonando ACP
3 Ventana orbitaria para oftálmica y ACI
4 ventana suboccipital para verebrales y basilar

Brain Emboli Distribution and Differentiation During Cardiopulmonary Bypass

Measurements and Main Results: Patients were divided into 3 groups depending on the CPB circuit used (open, open with vacuum, or closed). There was a significant difference between the number of solid and gaseous microemboli ($p < 0.001$), with the solid lower than the gaseous ones. The number of solid microemboli was affected by group ($p < 0.05$), CPB phase ($p < 0.001$), and laterality ($p < 0.01$). The number of gaseous microemboli was affected only by group ($p < 0.05$) and CPB phase ($p < 0.001$). Generally, the length of CPB phase did not affect the number of microemboli.

Conclusions: Surgical procedures combined with CPB circuits, but not the CPB phase length, affected the occurrence, nature, and laterality of microemboli.

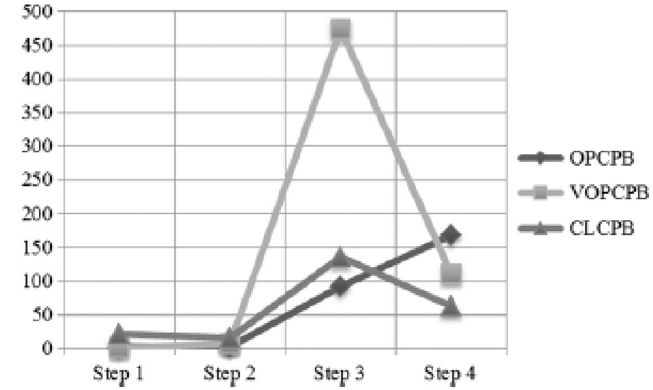


Fig 3. Mean number of solid microemboli by both group and CPB's step. OPCPB, open CPB; VOPCPB, open CPB with vacuum-assisted venous drainage; CLCPB, closed CPB; CPB, cardiopulmonary bypass.

Journal of Cardiothoracic and Vascular Anesthesia, Vol 27, No 5 (October), 2013: pp 865–875

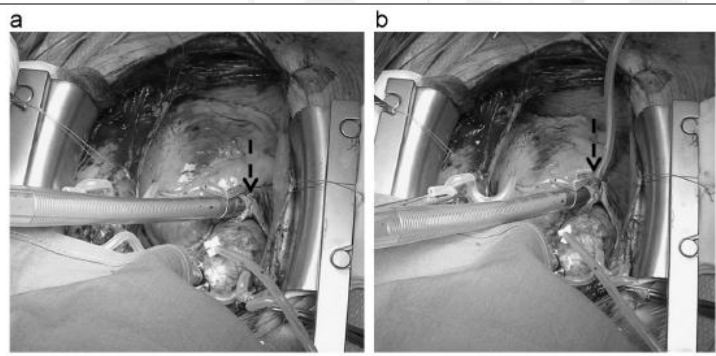


Fig 6. Right atrial cannulation. (a) Pursestring suture around the right atrium and venous cannula. (b) Pursestring suture added as an extra tie around the right atrium and venous cannula.

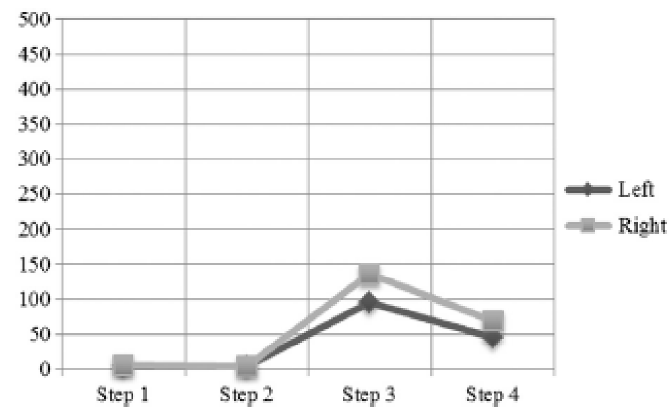


Fig 4. Mean number of solid microemboli by both CPB step and laterality.

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Asymptomatic and Symptomatic Postoperative Visual Dysfunction After Cardiovascular Surgery With Cardiopulmonary Bypass: A Small-Sized Prospective Observational Study

Objective: Postoperative visual dysfunction (POVD) after cardiovascular surgery rarely is reported, since it is more likely underdetected and underreported. This study was designed to verify the presence of POVD, including a variety of asymptomatic as well as symptomatic visual dysfunctions after cardiovascular surgery with cardiopulmonary bypass (CPB).

Design: A prospective observational study.

Setting: Cardiothoracic surgery in a medical university hospital.

Participants: Seventy-one patients undergoing elective cardiovascular surgery with CPB.

Interventions: None.

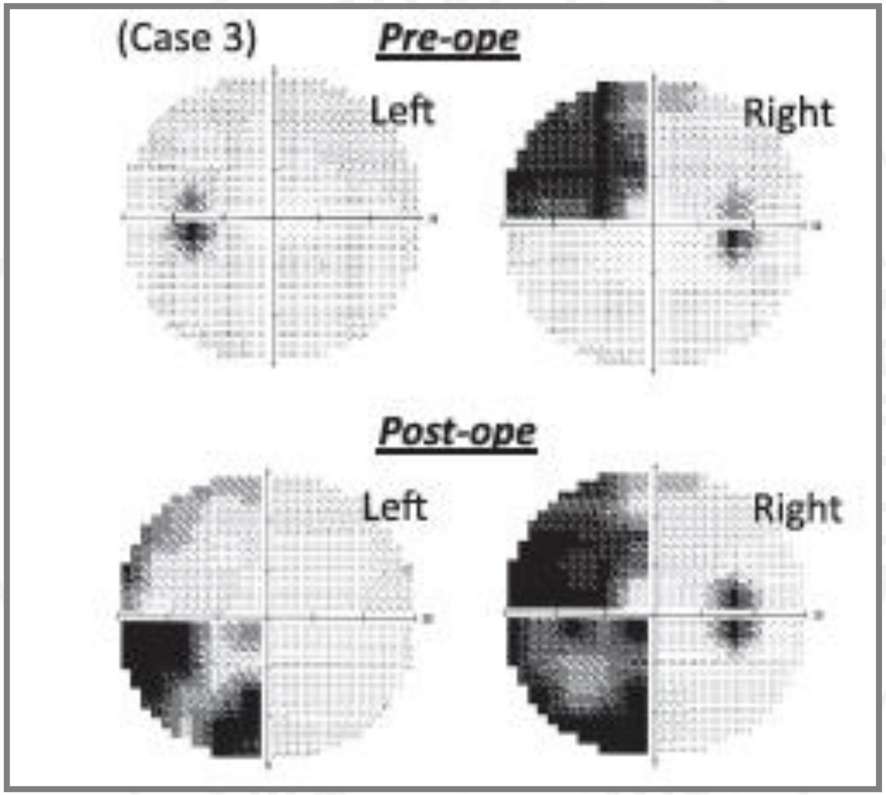
Measurements and Main Results: All patients were assessed by a battery of 7 neuro-ophthalmic examinations preoperatively and postoperatively, including fundus, visual field, eye movement, color vision, visual acuity, intraocular pressure, and critical flicker frequency. Patients were considered to have POVD if they had postoperative new abnormal findings of neuro-ophthalmic examinations. One patient was excluded due to a failure of postoperative neuro-ophthalmic examinations. In 16 of 70 patients analyzed in this study, selective cerebral perfusion was required for aortic arch surgery. Of 70 patients, a total of 8 patients (11.4%) had postoperative new abnormal findings in neuro-ophthalmic examinations, including new visual field deficits in 4, reduced visual acuity in 4, and/or increased intraocular pressure in 1 patient. Of these 8 patients, symptomatic POVD was recognized in 1 patient (1.4%) with postoperative visual field deficit and reduced visual acuity. There were no new abnormal findings compared with preoperative results in postoperative funduscopy, eye movement, color vision, and critical flicker frequency.

Conclusions: These results indicated that the asymptomatic as well as symptomatic POVD can develop after cardiovascular surgery with CPB, and their incidence may be relatively high.

KEY WORDS: postoperative complication, vision, ocular, asymptomatic disease, cardiovascular surgical procedures, cardiopulmonary bypass

Fig. 1. (Case 3) A 76-year-old male underwent elective total aortic replacement using cardiopulmonary bypass with antegrade selective cerebral perfusion. Three hundred minutes of cardiopulmonary bypass (CPB) and 30 minutes of hypothermic circulatory arrest were required. There were no intraoperative episodes of decreased regional cerebral saturation (rSO_2) to the level of less than 80% of control value for more than 5 minutes. Preoperative visual field examination revealed the upper nasal quadrantanopia of the right eye caused by cerebral infarction, while visual field of the right eye was normal. Postoperative visual field examination revealed the new visual field deficit (symptomatic left lower quadrantanopia on bilateral eyes). Postoperative cerebral magnetic resonance imaging showed right parietal-occipital cerebral infarction, which was not recognized preoperatively. This postoperative visual field defect was considered to be caused by cerebral infarction.

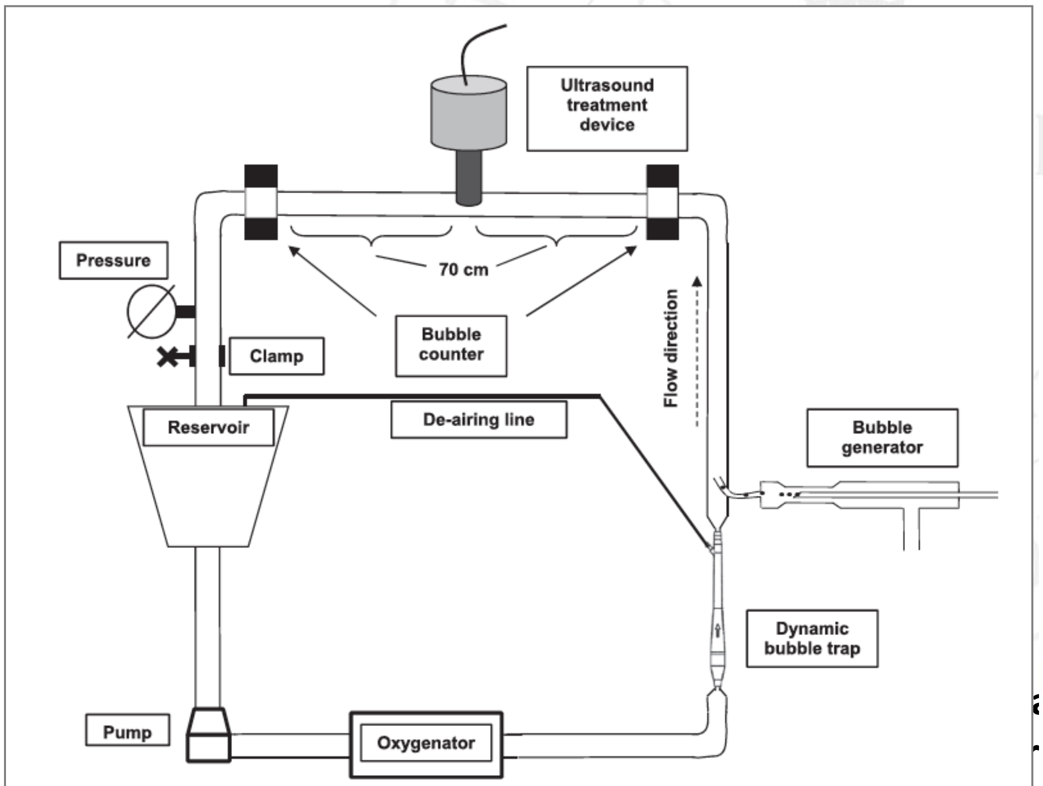
Asymptomatic and Symptomatic Postoperative Visual Dysfunction After Cardiovascular Surgery With Cardiopulmonary Bypass: A Small-Sized Prospective Observational Study



Ultrasound Destruction of Air Microemboli as a Novel Approach to Brain Protection in Cardiac Surgery

Conclusions: Ultrasound destruction of air emboli is a very efficient method to reduce number and size of emboli. Within the limits of safety assessment, the authors could not detect relevant side effects on standard blood parameters.

Journal of Cardiothoracic and Vascular Anesthesia, Vol 27, No 5 (October), 2013: pp 876–883



1. Flujo sanguineo cerebral

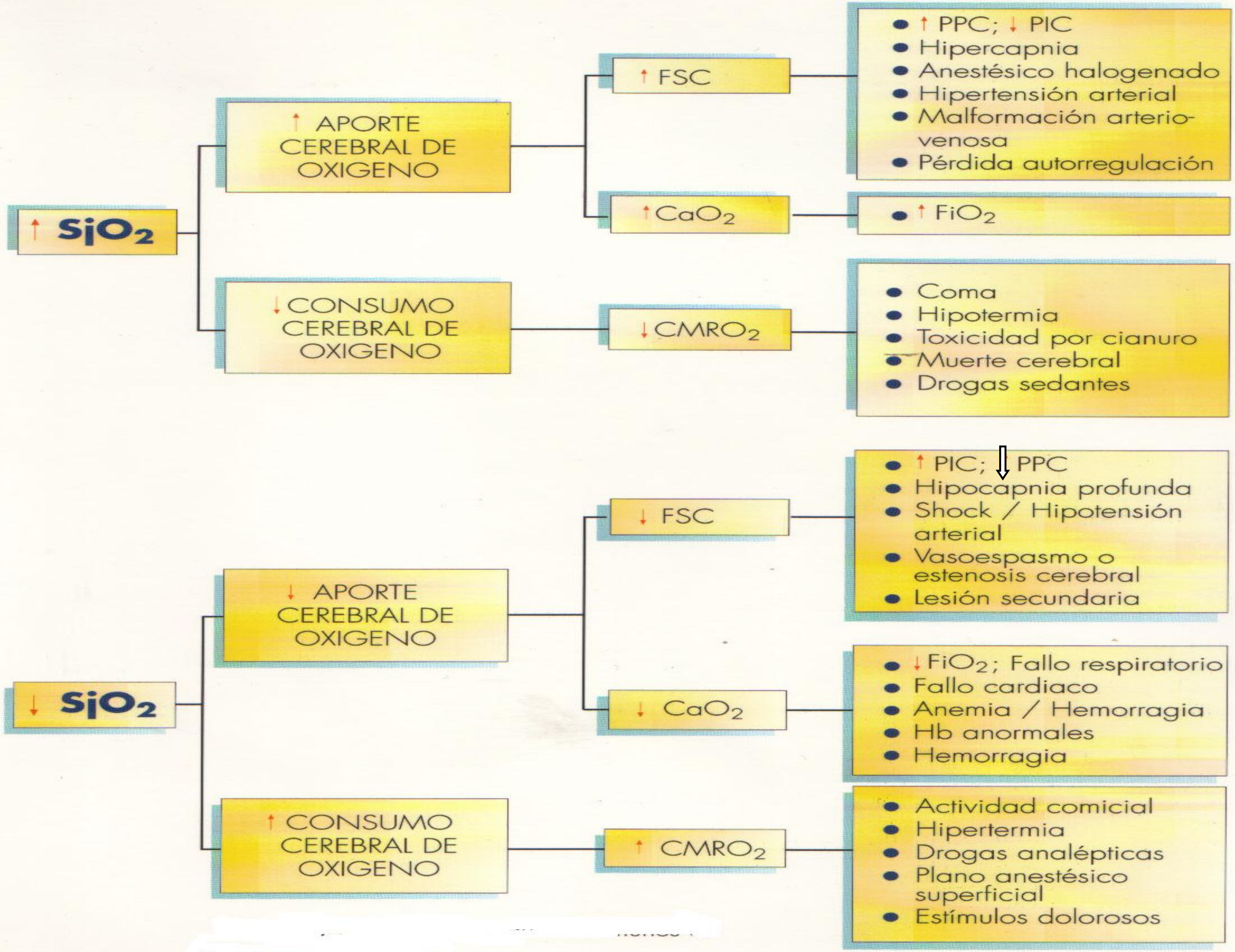
    Doppler Transcraneal

2. Sat regional de oxígeno

    INVOS / Equanox

3. EEG y derivados.

    BIS/Sedline



↑ SjO_2
↑ APORTE CEREBRAL DE OXIGENO
↑ FSC
• ↑ PPC; ↓ PIC
• Hipercapnia
• Anestésico halogenado
• Hipertensión arterial
• Malformación arterio-venosa
• Pérdida autorregulación
↑ CaO_2
• ↑ FiO_2
↓ CONSUMO CEREBRAL DE OXIGENO
↓ $CMRO_2$
• Coma
• Hipotermia
• Toxicidad por cianuro
• Muerte cerebral
• Drogas sedantes
↓ SjO_2
↓ APORTE CEREBRAL DE OXIGENO
↓ FSC
• ↑ PIC; ↓ PPC
• Hipocapnia profunda
• Shock / Hipotensión arterial
• Vasoespasmo o estenosis cerebral
• Lesión secundaria
↓ CaO_2
• ↓ FiO_2; Fallo respiratorio
• Fallo cardiaco
• Anemia / Hemorragia
• Hb anormales
• Hemorragia
↑ CONSUMO CEREBRAL DE OXIGENO
↑ $CMRO_2$
• Actividad comicial
• Hipertermia
• Drogas analépticas
• Plano anestésico superficial
• Estímulos dolorosos

Cerebral oximetry in cardiac and major vascular surgery

G.W. Fischer, G. Silvay

Department of Anesthesiology, Mount Sinai School of Medicine, New York, NY

HSR Proceedings in Intensive Care and Cardiovascular Anesthesia 2010; 2: 249-2

ABSTRACT

We describe the development and current applications of cerebral oximetry (based on near-infrar reflectance spectroscopy) that can be used during cardiac and major vascular surgery to determin brain tissue oxygen saturation. There are presently three cerebral oximetry devices with FDA approv in the United States to measure and monitor cerebral tissue oxygen saturation. 1. INVOS (Somanet Corporation, Troy, MI - recently COVIDIEN, Boulder, CO); FORE-SIGHT (CAS Medical Systems, I Branford, CT); EQUANOX (Nonin Medical Inc. Minnesota, MN). All devices are portable, non-invasi and easy to use in operating room and intensive care unit. The data provided in these communicati may provided information for improvement of perioperative neuromonitoring techniques, and may crucial in the design of future clinical trials.

Keywords: *cerebral oximetry, detection of cerebral hypopefusion or ischemia.*

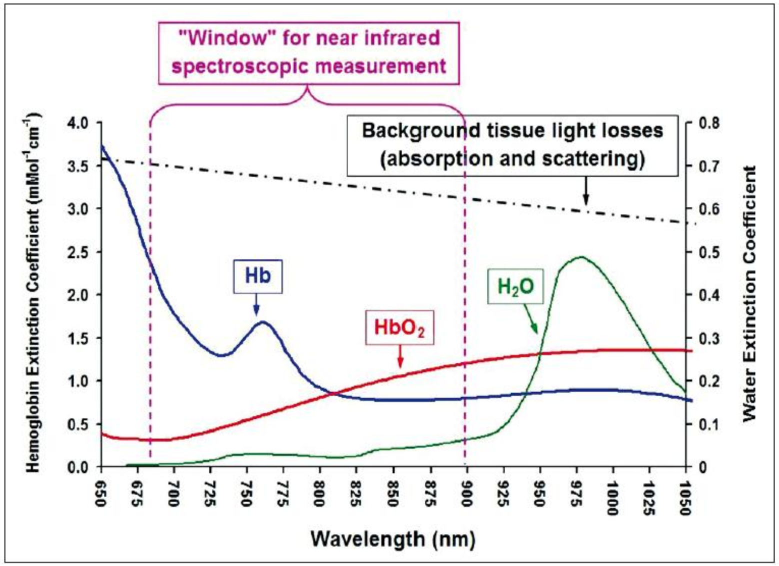
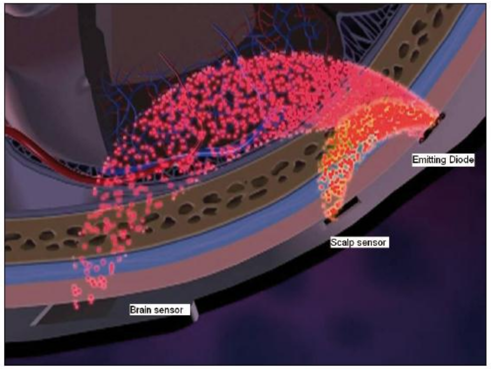
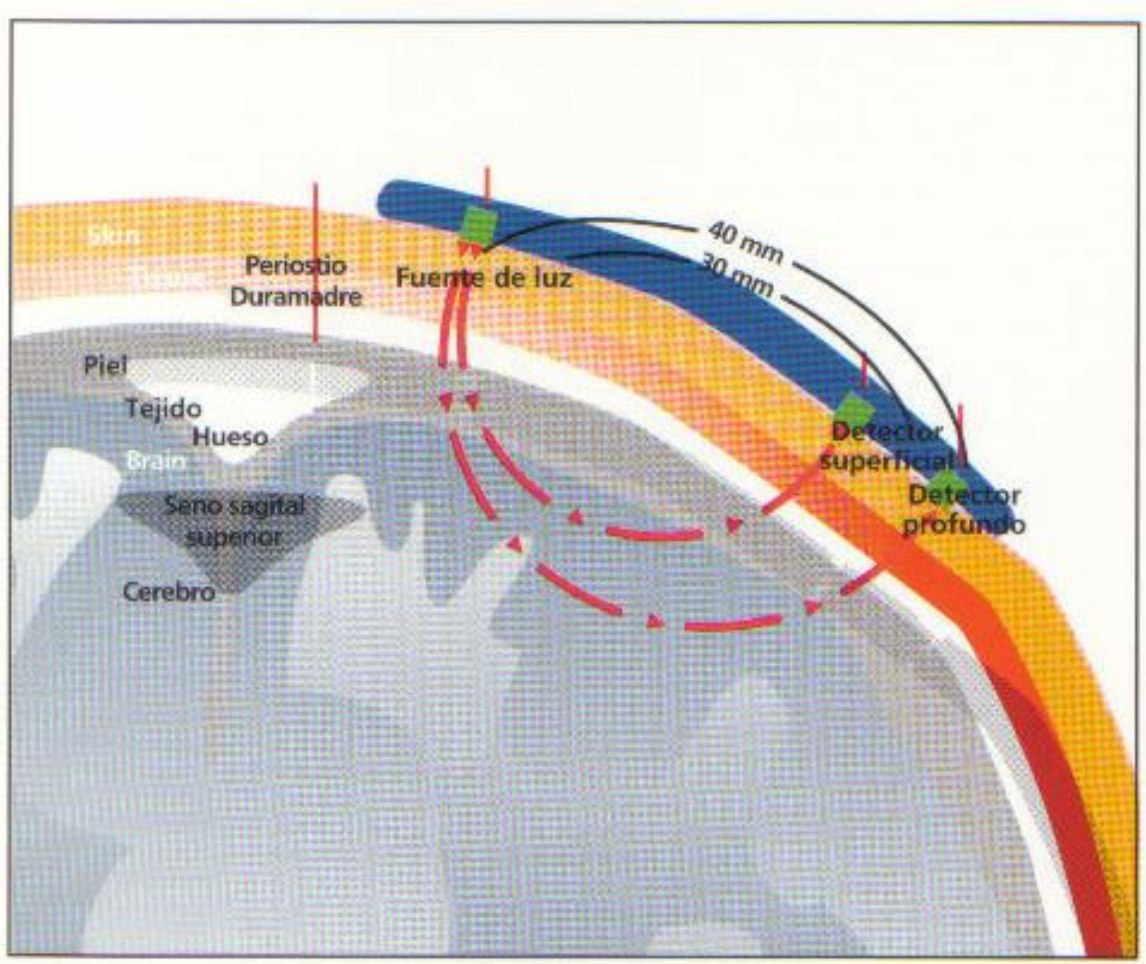


Figure 1
Near-infrared light passes through skin and skull readily and is absorbed by certain biological molecules in the brain. A "biological spectroscopic window" exists at the wavelength range 660 - 940 nm.

Ventajas:
1.SrO2 continua y no invasiva
2.Es un índice de hipoperfusión , hipoxia e isquemia cerebral
3.Puede ubicarse en quirófano o UCC



Debe minimizar la contaminación extracerebral
La penetración de la luz es proporcional a la distancia entre el emisor y el receptor



Detector superficial: dermis, epidermis, hueso
Detector profundo: dermis, epidermis, tejido cerebral (>85%)

Severe brain injury ICU outcomes are associated with Cranial-Arterial Pressure Index and noninvasive Bispectral Index and transcranial oxygen saturation: a prospective, preliminary study

C Michael Dunham, Kenneth J Ransom, Clyde E McAuley, Brian S Gruber, Dev Mangalat and Laurie L Flowers

Conclusion Numerous significant associations with ICU outcomes indicate that BIS and $StcO_2$ are clinically relevant. The independent associations of BIS, $StcO_2$, and ICP with outcomes suggest that noninvasive multi-modal monitoring may be beneficial. Future studies of patients with BIS ≥60 or $StcO_2$ ≥70 will determine if select patients can be managed without ICP monitoring and whether marginal ICP can be observed. An increased CAP index is associated with poor outcome.

SrO2 y status epiléptico

•Detección evento- correlación con EEG (episodio silente)- frecuente en neonatos y niños

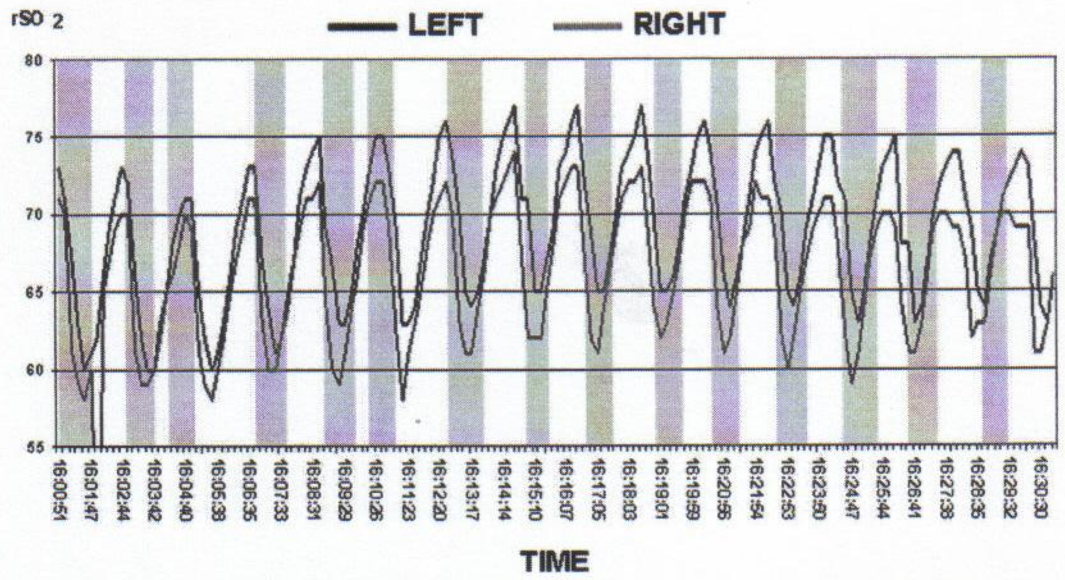
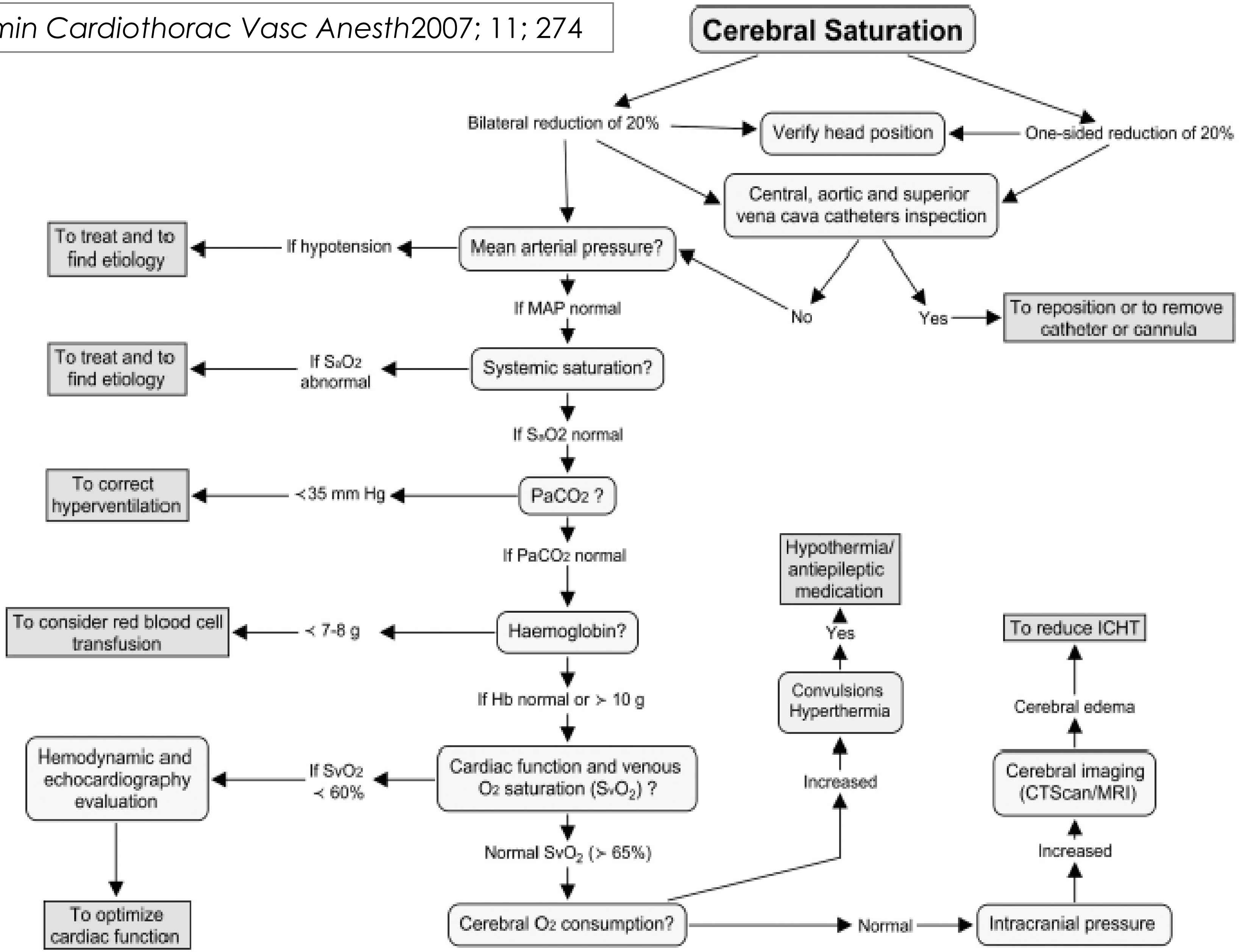


Fig. 1 – NIRS recording during repetitive electroencephalographic seizures with subtle clinical manifestations. rSO_2: regional oxygen saturation. Shaded areas establish the temporal relation between seizures and the rSO_2 changes.

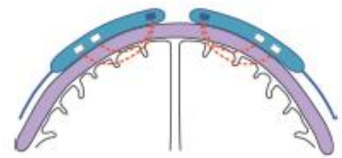
Europen Journal of Paediatric Neurology 2006;10: 19-21
J of Child Neurology 2004; 19(5): 394-6
J of Child Neurology 2004; 19(7): 539-40

Semin Cardiothorac Vasc Anesth 2007; 11; 274



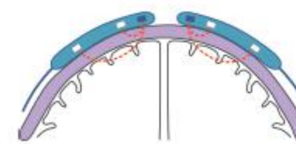
Alain Deschamps, PhD, MD,* Jean Lambert, PhD,† Pierre Couture, MD,* Antoine Rochon, MD,* Jean-Sébastien Lebon, MD,* Christian Ayoub, MD,* Jennifer Cogan, MD,* and André Denault, MD, PhD*

INVOS (Somanetics corporation, Troy, MI)
1993 / Utiliza DOS longitudes de onda de infrarrojo (730-8
emitidas por diodos (LEDs) / 4 canales /Update 6 seg



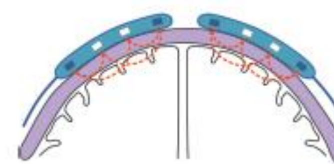
INVOS

FORE-SIGHT (CAS medical Systems, Inc. Branford, CT)
2007 / Utiliza LUZ LÁSER (690, 780, 805, 850 nm) que permiten obviar la contaminación (fluidos, tejidos, pigmentos)
Update cada 2 seg.



FORE-SIGHT

EQUANOX (Nonin Medical Inc, Minnesota, MN)
2009 / LEDs (730, 810, 880 nm)/ update 1.4 seg



EQUANOX

Journal of Cardiothoracic and Vascular Anesthesia, Vol 20, No 3 (June), 2006: pp 445-449

PRO AND CON

Lee A. Fleisher, MD
Bonnie L. Milas, MD
Section Editors

Cerebral Oximetry Should be a Routine Monitor During Cardiac Surgery

Pro: All Cardiac Surgical Patients Should Have Intraoperative Cerebral Oxygenation Monitoring

Harvey L. Edmonds Jr, PhD

In fact, there is close agreement between the findings of the prospective and retrospective studies examining the clinical benefit of cerebral oximetry for cardiac surgery. The available 11 retrospective cardiac surgery studies that incorporated a standardized intervention protocol comprise an aggregate study population exceeding 7,000.[35-45] All these studies found that intraoperative rSO_2 monitoring was associated with significant reductions in neurologic injury, duration of hospital stay, or both. In addition, a growing number of case reports show likely prevention of catastrophic brain injury with cerebral oximetric monitoring.[46-55]

Con: All Cardiac Surgical Patients Should Not Have Intraoperative Cerebral Oxygenation Monitoring

Laurie K. Davies, MD, and Gregory M. Janelle, MD

Although the concept of being able to monitor cerebral oxygenation is an attractive one, the current available technology has not proven itself to be accurate or reliable nor has its use unequivocally resulted in improved outcomes. There remains disagreement in the literature as to whether trends (percent deviation from baseline) are more important than absolute values below a certain threshold. Because of the lack of evidential weight that cerebral oximetry can determine even hemispheric cerebral hypoperfusion in carotid ischemia models with any degree of certainty, it is almost impossible for a clinician to determine in real time whether the patient's brain is at risk or whether the observed data are spurious. Similarly, in the cardiopulmonary bypass patient population, most positive outcome studies involving cerebral oximetry include multimodal neuromonitoring. This fact, coupled with the multimodal nonstandardized interventional strategies, result in much difficulty in ascertaining the clinical impact of oximetry monitoring alone. Although it is conceivable that technologic advances with respect to cerebral oximetry monitors or further studies using the devices may result in identification of rSO_2 alarms or treatment triggers that provide indisputable evidence for routine use of the device, it must regrettably be concluded that evidential weight is lacking for use of cerebral oximetry as a current standard of care in cardiac surgery.

JOURNAL OF CARDIOTHORACIC SURGERY

Monitoring of brain oxygen saturation (INVOS) in a protocol to direct blood transfusions during cardiac surgery: a prospective randomized clinical trial

Vretzakis et al. Journal of Cardiothoracic Surgery 2013, 8:145

Abstract

Background: Blood transfusions are common in cardiac surgery, but have been associated with increased morbidity and long-term mortality. Efforts to reduce blood product use during cardiac surgery include fluid restriction to minimize hemodilution, and protocols to guide transfusion decisions. INVOS is a modality that monitors brain tissue oxygen saturation, and could be useful in guiding decisions to transfuse. However, the role o INVOS (brain tissue oxygen saturation) as part of an algorithm to direct blood transfusions during cardiac surgery has not been evaluated. This study was conducted to investigate the value of INVOS as part of a protocol for bloo transfusions during cardiac surgery.

Methods: Prospective, randomized, blinded clinical trial, on 150 (75 per group) elective cardiac surgery patients. The study was approved by the Institution Ethics committee and all patients gave written informed consent. Data were initially analyzed based on "intention to treat", but subsequently were also analyzed "per protocol".

Results: When protocol was strictly followed ("per protocol analysis"), compared to the control group, significantly fewer patients monitored with INVOS received any blood transfusions (46 of 70 patients in INVOS group vs. 55 of 67 patients in the control group, p = 0.029). Similarly, patients monitored with INVOS received significantly fewer units of red blood cell transfusions intraoperatively (0.20 ± 0.50 vs. 0.52 ± 0.88, p = 0.008) and overall during hospital stay (1.31 ± 1.20 vs. 1.82 ± 1.46, p = 0.024). When data from all patients (including patient with protocol violation) were analyzed together ("intention to treat analysis"), the observed reduction of blood transfusions in the INVOS group was still significant (51 of 75 patients transfused in the INVOS group vs. 63 of 75 patients transfused in the control group, p = 0.021), but the overall number of units transfused per patient did not differ significantly betwee the groups (1.55 ± 1.97 vs. 1.84 ± 1.41, p = 0.288).

Conclusions: Our data suggest that INVOS could be a useful tool as part of an algorithm to guide decisions for blood transfusion in cardiac surgery. Additional data from rigorous, well designed studies are needed to further evaluate the role of INVOS in guiding blood transfusions in cardiac surgery, and circumvent the limitations of this study.

Trial registration: ClinicalTrials.gov: NCT00879463

Keywords: INVOS, Cardiac surgery, Anesthesia, Transfusion, Fluid restriction, Near-infrared spectroscopy

Impact of Extracranial Contamination on Regional Cerebral Oxygen Saturation

A Comparison of Three Cerebral Oximetry Technologies

Sophie N. Davie, B.Sc.,* Hilary P. Grocott, M.D., F.R.C.P.C.†

Anesthesiology 2012;116:834-40

Conclusions: Extracranial contamination appears to significantly affect NIRS measurements of cerebral oxygen saturation. Although the clinical implications of these apparent inaccuracies require further study, they suggest that the oxygen saturation measurements provided by cerebral oximetry do not solely reflect that of the brain alone.

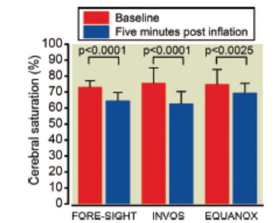
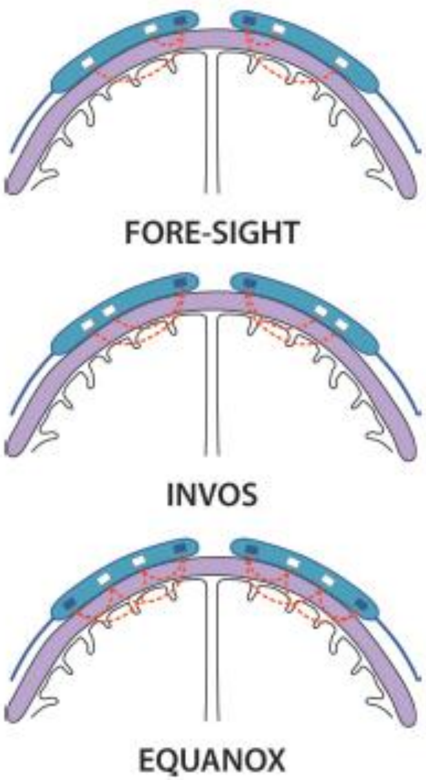


Fig. 4. Regional cerebral oxygen saturation measurements of FORE-SIGHT, INVOS 5100C-PB, and EQUANOX Classic 7600, the three near-infrared spectroscopy devices studied at baseline and at 5 min postinflation of a head cuff. All three of the cerebral oximeters demonstrated a statistically significant reduction in cerebral oxygen saturation at 5 min postinflation. *Error bars* represent the standard deviations.



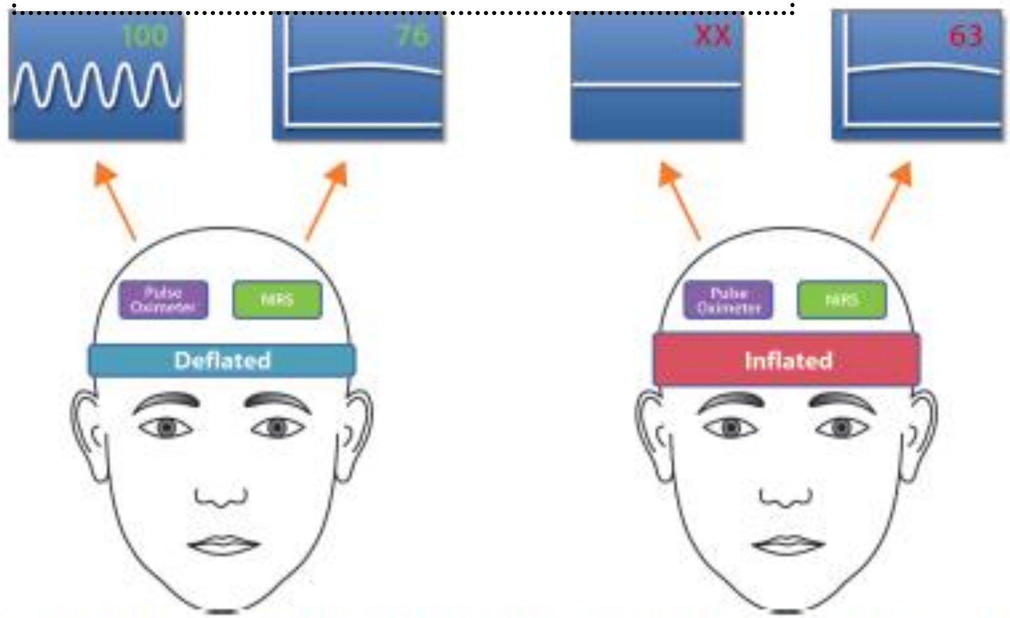


Fig. 2. Schematic diagram of placement of the circumferential pneumatic head cuff, surface scalp pulse oximeter, and cerebral oximetry optode array. With inflation of the head cuff, a loss of blood flow to the scalp results in a loss of signal from the surface scalp pulse oximeter and tissue hypoxia-ischemia. NIRS = near-infrared spectroscopy.

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SrO2 en Qx y UCC

Monitorización para neuroprotección:

- Pacientes con TCE severo:
  - Detección de disbalance aporte/consumo O2
  - Valorar colocación del sensor con TC : evitar sobre hematoma epidural o subdural, o infarto isquémico
- Pacientes sometidos a cirugía con riesgo de isquemia cerebral (p.ej., cirugía cardiaca, endarterectomía carotídea)

Limitación:

- Pequeña zona de monitorización

Annals of the New York Academy of Sciences 2001; 939

1. Flujo sanguineo cerebral

    Doppler Transcraneal

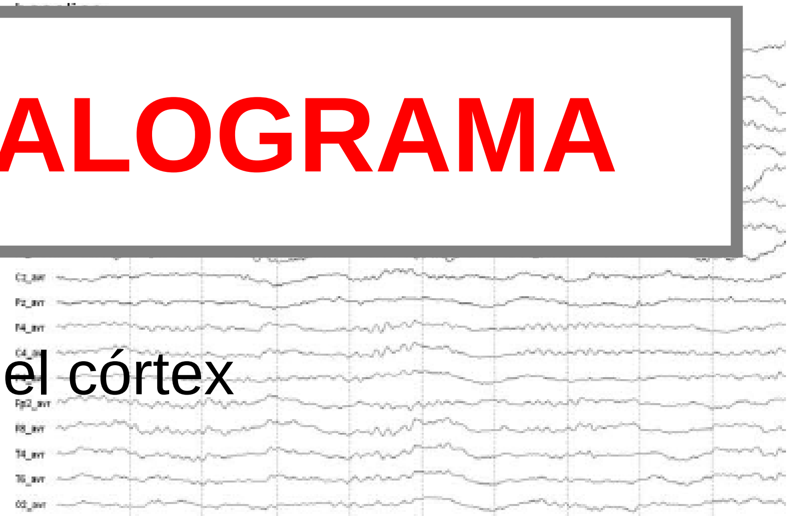
2. Sat regional de oxígeno

    INVOS / Equanox

3. EEG y derivados.

    BIS/Sedline

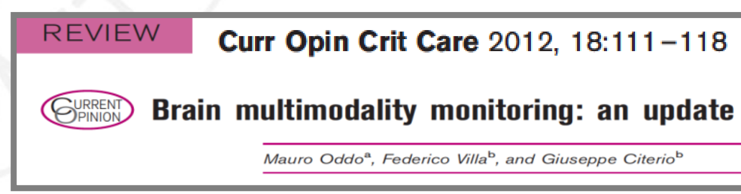
ELECTROENCEFALOGRAMA



- Estudio de la actividad eléctrica del córtex cerebral
- Herramienta útil para:
    - Detección de actividad convulsiva clínicamente silente (o pacientes con relajación muscular) 4-30% (según la sedación) →↑ daño secundario y pérdida de tejido

    - Monitorización de la profundidad del coma

    - Diagnóstico de muerte cerebral


REVIEW Curr Opin Crit Care 2012, 18:111–118

CURRENT OPINION Brain multimodality monitoring: an update

Mauro Oddo[a], Federico Villa[b], and Giuseppe Citerio[b]

SARTD-CHGUV Sesión de Formación Continuada
Valencia 21 de Enero de 2014

Review Article

Raoul Sutter, MD[1–4]; Robert D. Stevens, MD[1–5]; Peter W. Kaplan, MBBS, FRCP[2,4]

Continuous Electroencephalographic Monitoring in Critically Ill Patients: Indications, Limitations, and Strategies*

TABLE 3. The Role of Continuous Electroencephalography in the ICU

Critical Illness	Importance of Continuous Electroencephalography: For Seizure Detection	For Treatment/ Monitoring	For Prognosis	Cost-Effectiveness
Convulsive status epilepticus	+++	+++	++	+++
Nonconvulsive status epilepticus	+++	+++	++	Uncertain
Post-cardiorepiratory arrest	+++	+++	+++	+++
Intracerebral hemorrhage	++	+	Uncertain	++
Subarachnoid hemorrhage	++	++ for vasospasms	++	++
Traumatic brain injury	++	++	++	Uncertain
Ischemic stroke	+	Uncertain	+	Uncertain
ICU patients with fluctuating mental status "not otherwise determined"	+	Uncertain	Uncertain	Uncertain

Tentative grading of importance of continuous electroencephalography:+ = minor importance; ++ = moderate importance; +++ = strong importance.

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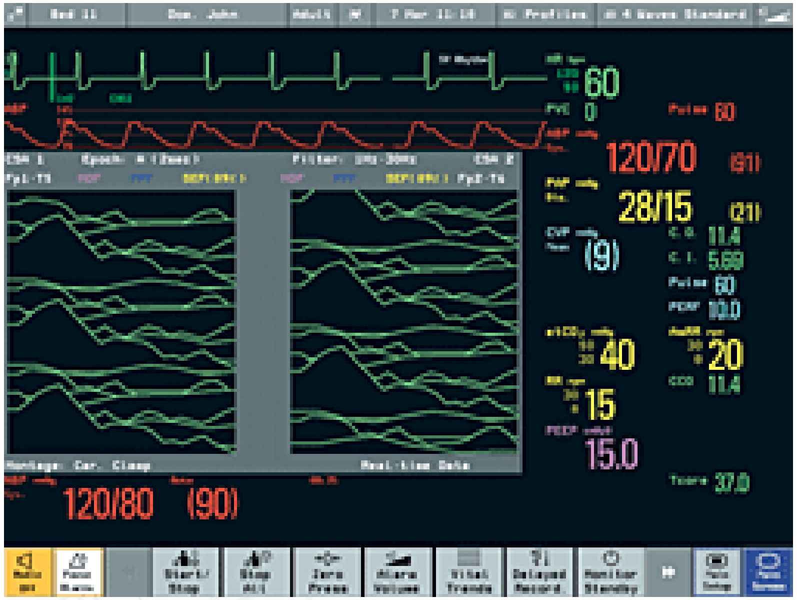


EEG cuantitativo (qEEG)

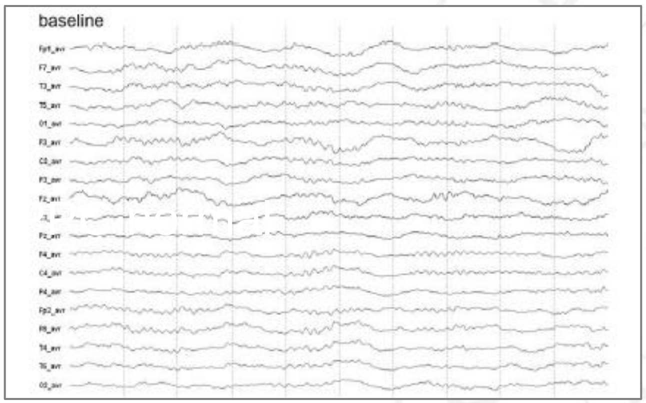
- Monitorización continua
- La señal EEG sin procesar se convierte en forma digital utilizando matriz espectral comprimida (compressed spectral array)
- Colaboración UCI / neurofisiología

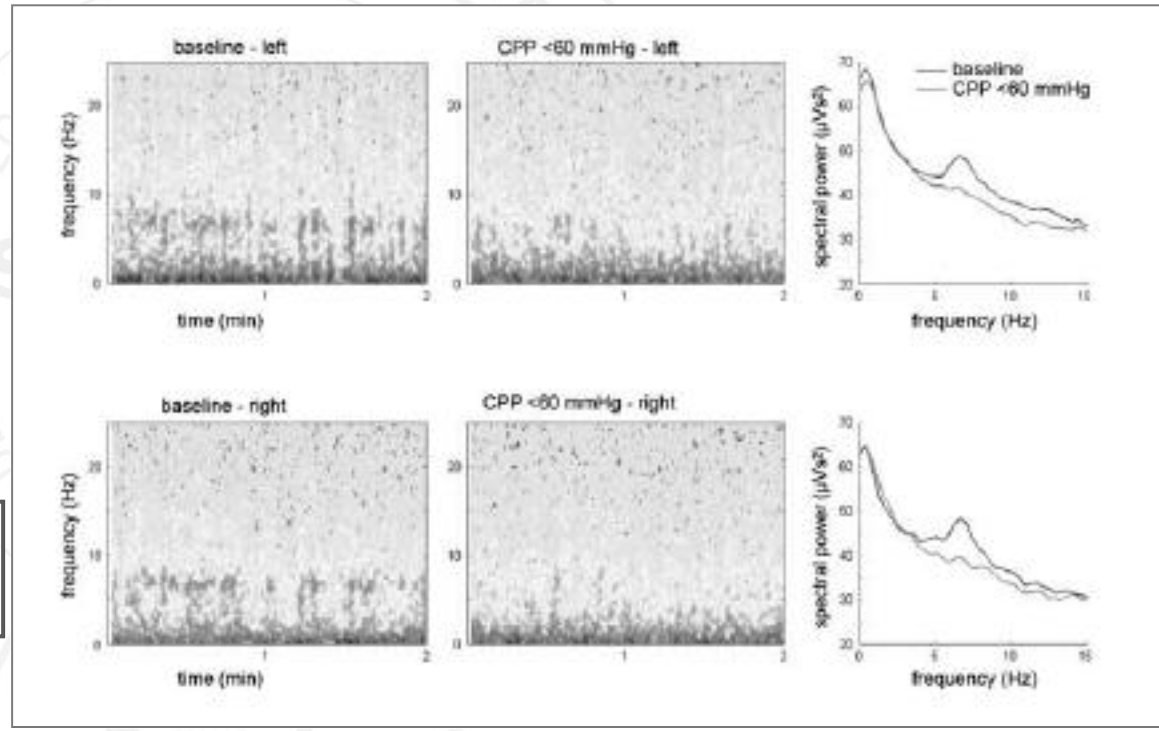
neurocritical care society Neurocrit Care (2009) 11:210–216
DOI 10.1007/s12028-009-9236-6

ORIGINAL ARTICLE

Quantitative EEG Correlates of Low Cerebral Perfusion in Severe Stroke

Jennifer Diedler · Marek Sykora · Thomas Bast ·





Durante la ↓PPC→↓actividad EEG rápida (3.5–20.7 Hz)

MEDICINA ESPAÑOLA

REVISTA NACIONAL DE MEDICINA, CIRUGÍA Y ESPECIALIDADES

Año XVII Tomo XXXI	Valencia, Mayo 1954	Núm. 182

DOCTRINA, INVESTIGACION Y CLINICA

I

Cátedra de Patología Quirúrgica de la Facultad de Medicina. Valencia
Prof. Dr. JOSÉ GASCÓ PASCUAL

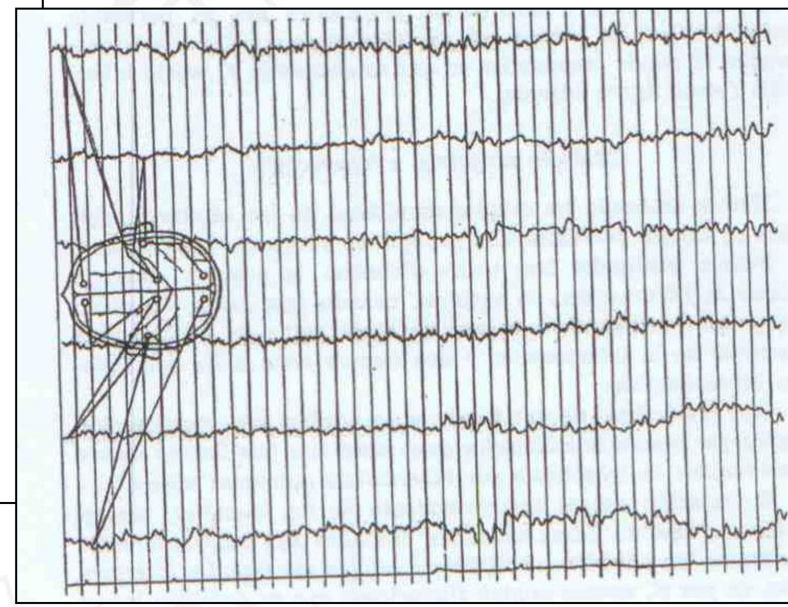
PROFILAXIS DE LA ENFERMEDAD POSTOPERATORIA POR LA HIBERNACION ARTIFICIAL *

por el

Prof. J. GASCÓ PASCUAL

con la colaboración de

F. GOMAR, B. NARBONA, V. MARUENDA, V. TORMO y J. BAGUENA



Por Cortesía de JI Marqués

The Journal of Thoracic Surgery

Vol. 34 | December, 1957 | No. 6

Original Communications

THE ELECTRO-ENCEPHALOGRAM IN PATIENTS UNDERGOING OPEN INTRACARDIAC OPERATIONS WITH THE AID OF EXTRACORPOREAL CIRCULATION

Richard A. Theye, M.D.* (by invitation), Robert T. Patrick, M.D.* (by invitation), and John W. Kirklin, M.D.**

Rochester, Minn.

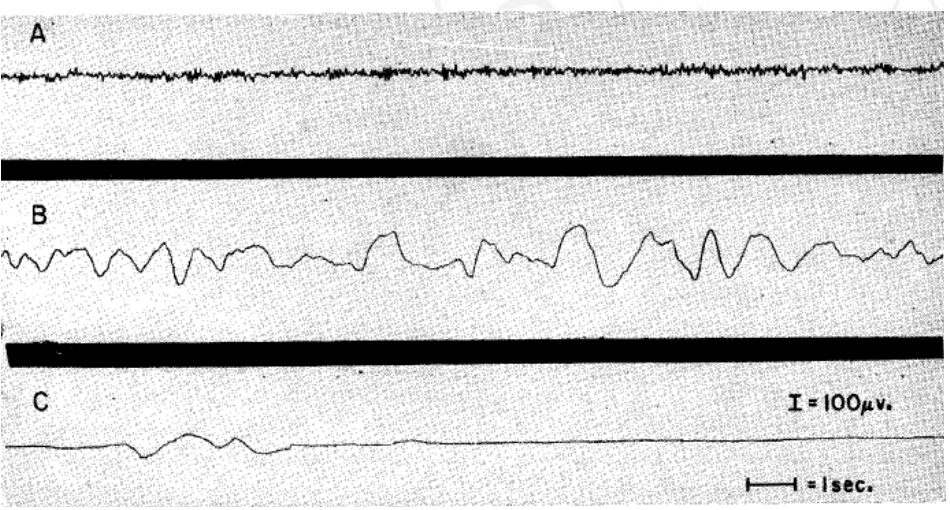


Table II. Instances of Assumed or Known Reduction of Blood Flow Associated With Change in Electro-encephalogram

DESCRIPTION OF INCIDENT	TREATMENT	RESULTS
Arterial line of bypass accidentally uncoupled; 6 minutes without flow; patient's temperature 34° to 32° C.; EEG immediately flat	Re-established perfusion	Flat EEG for 21 minutes, followed by large, slow waves for 2 to 3 hours; gradual appearance of fast activity; patient awake and rational with removal of endotracheal tube; uncomplicated convalescence without neurologic defect
Gradual circulatory deterioration with severe hypotension (40/30) in periods of 3 to 4 minutes before perfusion	Established perfusion	Reappearance of normal EEG
Hypovolemia in the same patient with additional loss of blood on removal of subclavian cannula; onset of flat EEG	Infusion of blood; intracardiac epinephrine and calcium gluconate; cardiac compression	Death
Severe hypotension during chest closure (30/25)	Intravenous infusion of Levophed	Normal blood pressure and gradual reappearance of normal EEG
Hypovolemia after perfusion; infusion of citrated blood in subclavian artery leading to ventricular fibrillation	Reinstitution of perfusion; defibrillation	Reappearance of normal EEG
Complete A-V dissociation after repair of ventricular septal defect; heart rate 24/min.; low mean blood pressure (70 to 90/10 to 20); onset of flat EEG	Intravenous infusion of epinephrine, Levophed, and molar sodium lactate; pacemaker	Death
Asystole at cessation of perfusion	Re-established perfusion; intracardiac epinephrine and calcium gluconate	Immediate reappearance of normal EEG; successful cessation of perfusion with normal EEG
In the same patient episodes of profound hypotension during closure of chest (40/30)	Intravenous infusion of Levophed	Adequate blood pressure and reappearance of normal EEG (see Fig. 3)
Hypotension during chest closure (50/20)	Intravenous infusion of Levophed	Blood pressure increased to 80/40; gradual reappearance of normal EEG
Several episodes of profound hypotension after perfusion	Massive doses of Levophed intravenously	Increase in blood pressure and reappearance of normal EEG in early episodes; death finally ensued
Inadequate circulation with cessation of perfusion following repair of ventricular septal defect in patient with associated irreparable mitral insufficiency; EEG flat	Re-established perfusion	Immediate reappearance of normal EEG (Fig. 4); perfusion finally discontinued in spite of inadequate circulatory dynamics; death ensued
Hypotension with manipulation of heart and great vessels	Cessation of manipulation	Gradual reappearance of normal EEG
Terminal circulatory deterioration following perfusion and repair of single ventricle; flat EEG	Intracardiac epinephrine and calcium gluconate; intravenous Levophed	Death

Por Cortesía de JI Marqués

Table 4. Comparison between Both Studied Groups

	No Recovery of Consciousness	Recovery of Consciousness
n	6	19
BIS minimum	36 (2–41)	40 (11–96)
BIS mean*	42.5 (13–48.5)	62.5 (35–97)
BIS maximum*	47.5 (24–56)	90 (40–98)
BIS range*	12.5 (3–22)	35 (2–72)
EMG*	0.5 (0–1)	3 (1–10)
BSR	2 (0–98)	0 (0–21)
SQI*	10 (9–10)	9 (4–10)
$SEF_{95\%}$ minimum	10.8 (6.5–11.3)	7.2 (2.8–15.3)
$SEF_{95\%}$ maximum	12 (8.5–20)	13.2 (5–28.5)
APACHE II	19.5 (11–29)	18 (8–26)
TISS	45.5 (41–54)	46 (26–72)
GCS admission	4 (3–8)	4 (3–13)
GCS day BIS*	3 (3–8)	8 (3–10)
Days of sedation	4.5 (0–9)	4 (1–17)
Days without sedation	3 (1–7)	2 (1–14)
Days of follow up	18 (2–90)	60 (18–180)

Data are expressed as median (range).

* $P < 0.05$.

BIS = Bispectral Index; BSR = burst suppression ratio; EMG = spontaneous frontal electromyography; GCS = Glasgow Coma Score; $SE_{95\%}$ = 95% Spectral edge frequency; SQI = signal quality index; TISS = Therapeutic Interventional Scoring System.

•BIS max < 50: no recuperación conciencia

•BIS max ≥ 90 : recuperación conciencia

Can biespectral index monitoring predict recovery of conciousness in patients with severe brain injury?

Fàbregas et al. Anesthesiology 2004;101:43-51

Valor pronóstico BIS en TCE grave

Grado discapacidad	BIS medio	BIS mínimo	BIS máximo	Tasa supresión
Normal	69'07	59'25	76'47	1'06
Leve	44'93	35'63	56'05	2'03
Moderada	42'24	36'95	48'43	9'05
Grave	50'35	47'73	53'51	19'36
Vegetativo	31'3	28'56	34'27	67'6

UCIP. Hospital Universitario de Salamanca. Gómez de Quero et al. SECIP

Conclusiones. El BIS podría ser una herramienta pronóstica del niño con TCE grave y otras lesiones neurológicas agudas no traumáticas. La presencia de BIS bajos (< 40) en ausencia de sedación con tasa de supresión > 5-10% nos indicaría un posible pronóstico neurológico desfavorable.

Registro de crisis comiciales

Recordad: la actividad comicial que no se refleje en regiones frontales no modificará significativamente la señal del BIS

Thiopental

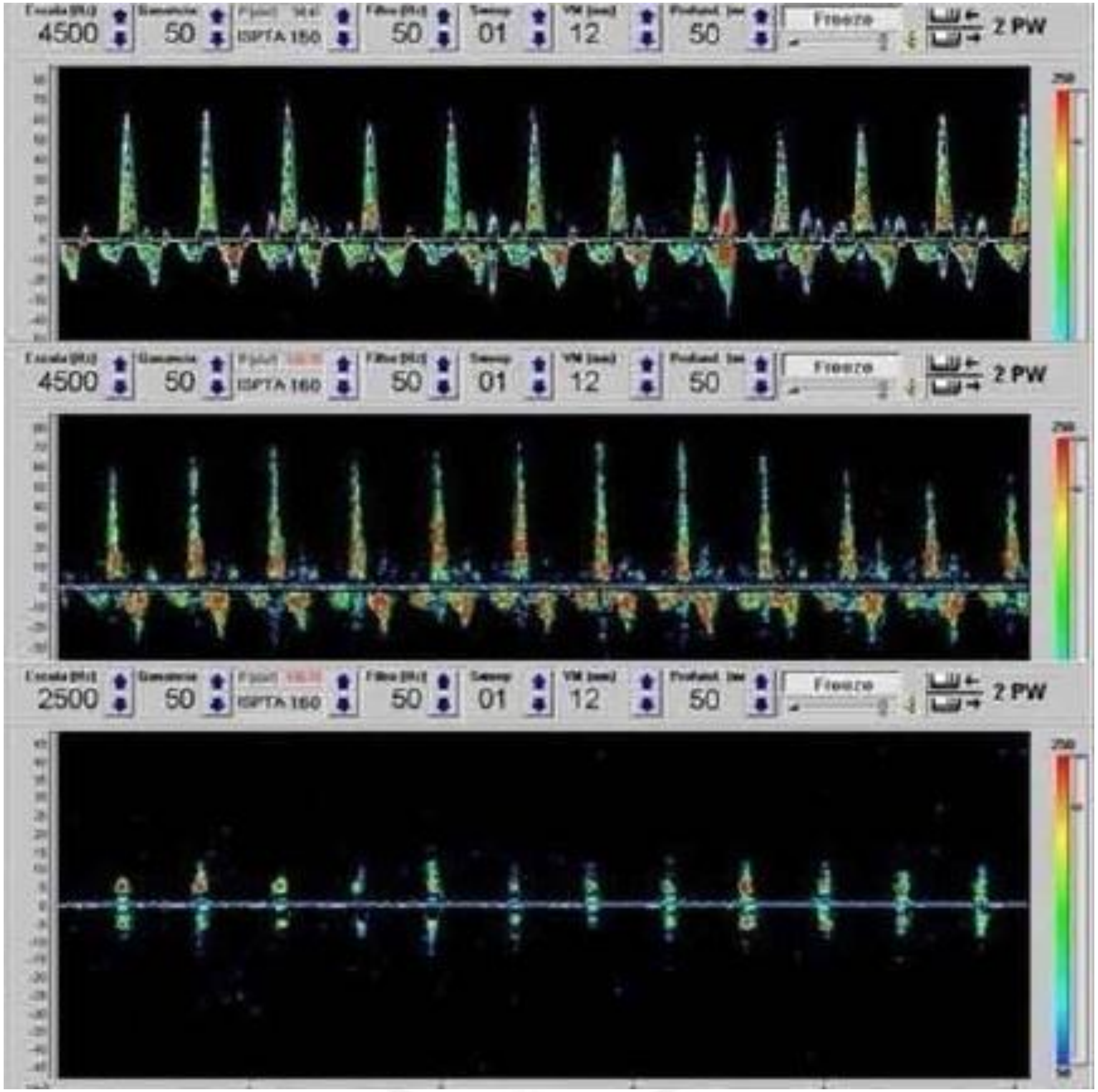
SARTD-CHGUV Sesión de Formación Continuada
Valencia 21 de Enero de 2014

Causas de falso aumento del BIS

- Actividad muscular: temblor
- Interferencia radiofrecuencia (marcapasos, Maze, ablación tumores, calentadores..)
- Ketamina, N2O, Enfluorane, Xenon
- Aumento contractilidad cardiaca (adrenalina)
- Efecto estimulante central similar al de las anfetaminas
- Patrón de sueño REM

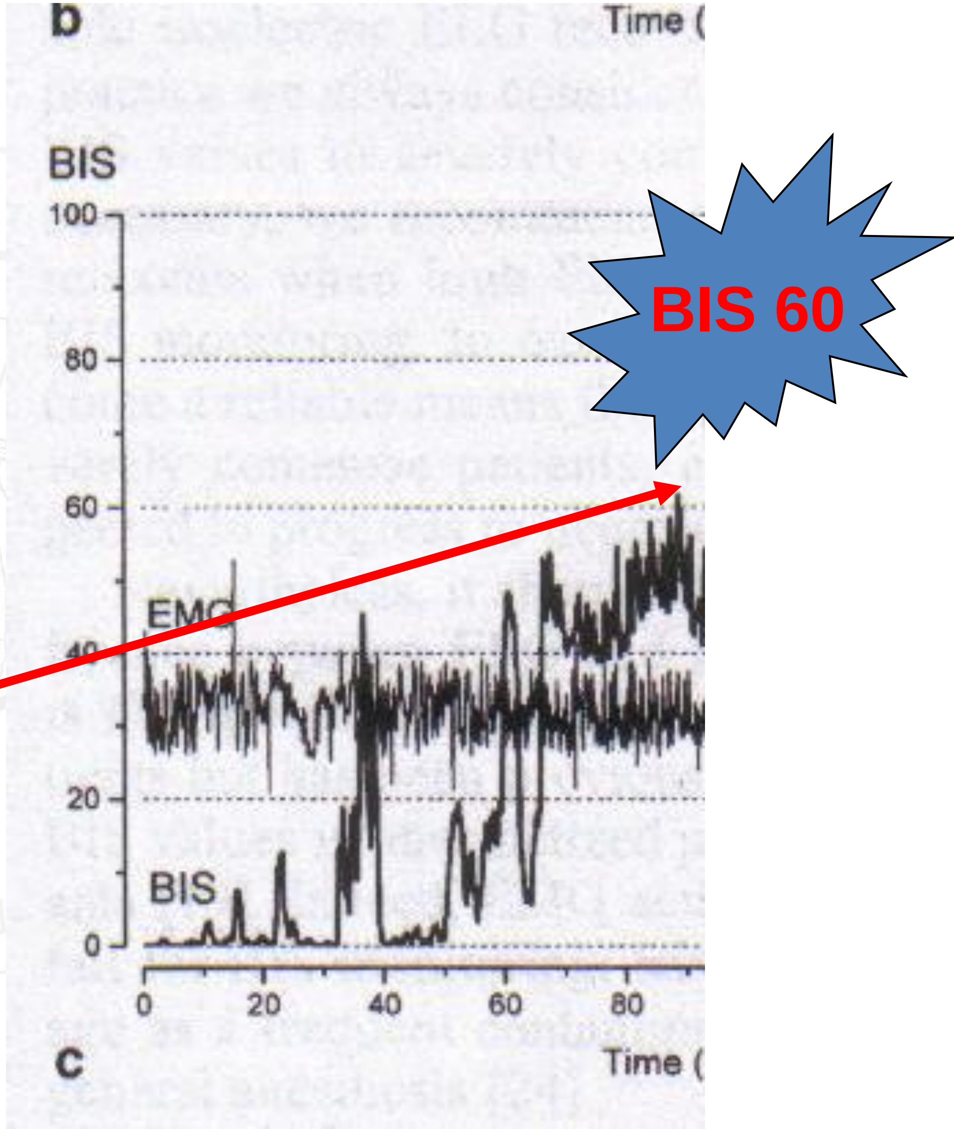
Caso clínico

- Paciente de 35 años que sufre TCE severo por accidente de ciclismo.
- El SAMU objetiva CGS 3 con herida inciso-contusa parieto-occipital izquierda y pérdida de masa encefálica
- Se traslada a UCI de centro de referencia tras IOT y estabilización HMDC con adrenalina 0,8 mcg/kg/min


4500
50
ISPTA 160
50
01
12
50
Freeze
2 PW
4500
50
ISPTA 160
50
01
12
50
Freeze
2 PW
2500
50
ISPTA 160
50
01
12
50
Freeze
2 PW

- Tras 24 h sin sedación en UCI y ante CGS 3, DTC con signos de muerte encefálica y BIS de 0 se contacta con el Equipo de trasplantes
- Se considera donante válido y pasa a quirófano para extracción de órganos

Antes de su traslado a quirófano para proceder a la extracción de órganos se observa lo siguiente:



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Valencia 21 de Enero de 2014

1. El paciente no está en muerte encefálica
2. No se trata de un artefacto
3. Debe rechazarse este donante
4. Puede tratarse de un artefacto
5. Todas las anteriores son correctas
6. NS /NC

1. El paciente no está en muerte encefálica
2. No se trata de un artefacto
3. Debe rechazarse este donante
4. Puede tratarse de un artefacto*
5. Todas las anteriores son correctas
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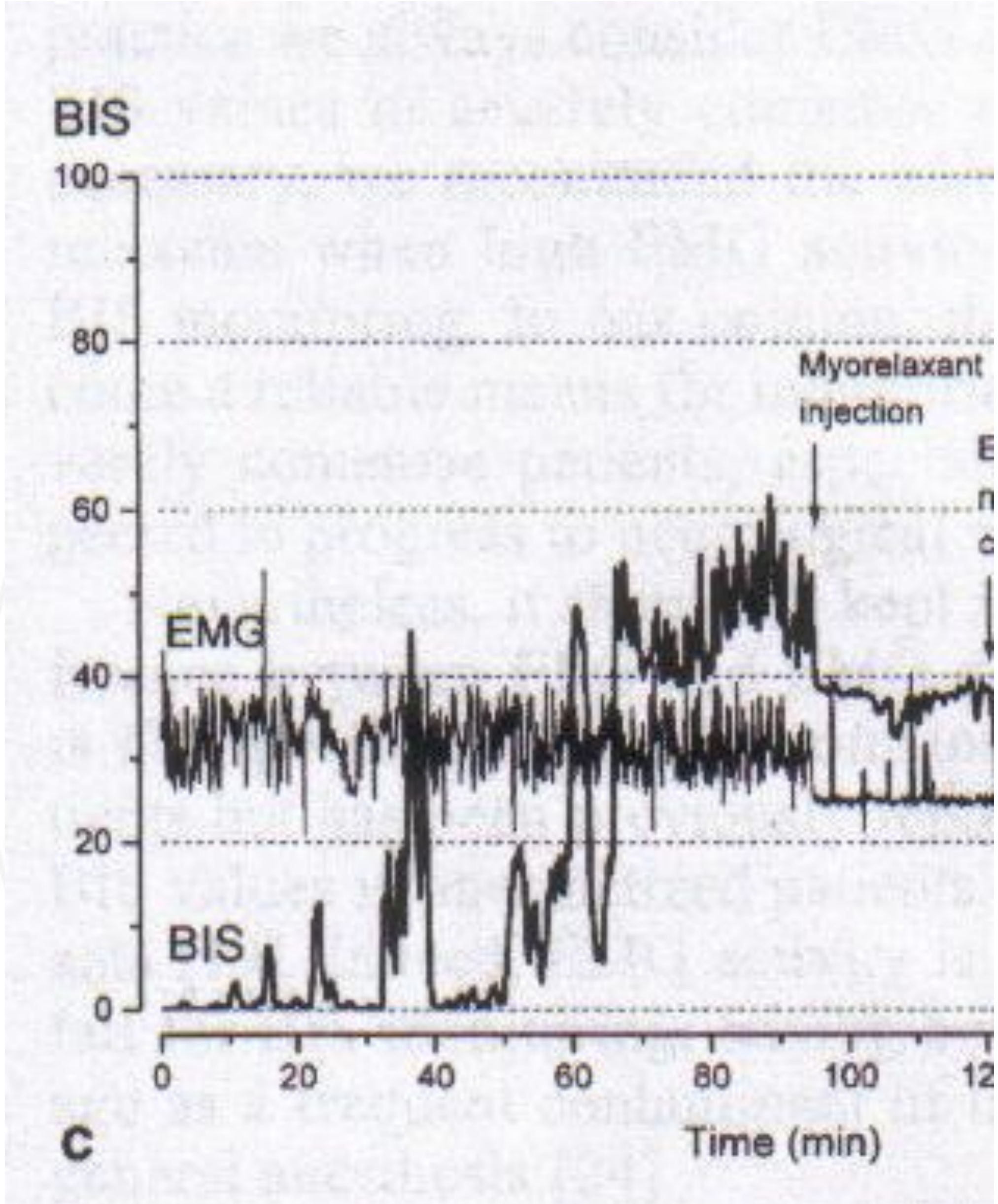
BIS
100
80
60
40
20
0
EMG
BIS
Myorelaxant injection
0
20
40
60
80
100
C
Time (min)

A pesar de administrar una dosis adecuada de relajante muscular, el BIS continua siendo de 40:

1. El paciente no está en muerte encefálica
2. No se trata de un artefacto
3. Debe rechazarse este donante
4. Puede tratarse de un artefacto
5. Todas las anteriores son correctas
6. NS /NC

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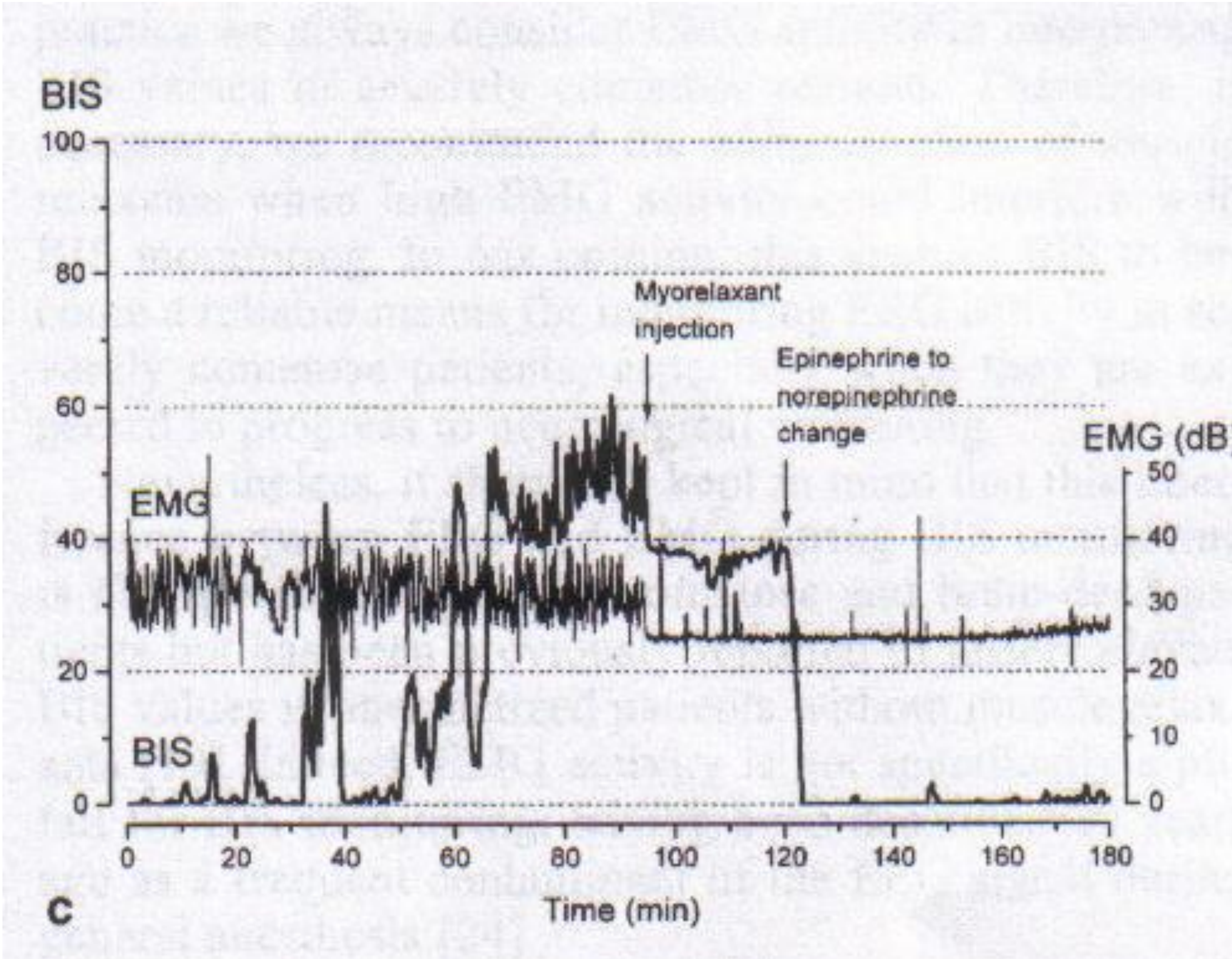
3. Debe rechazarse este donante
4. Puede tratarse de un artefacto*
5. Todas las anteriores son correctas
6. NS /NC



Intensive Care Med (2002) 28

Causas de falso aumento del BIS

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- Ketamina, N2O, Enfluorane, Xenon
- Aumento contractilidad cardiaca (adrenalina)
- Efecto estimulante central similar al de las anfetaminas
- Patrón de sueño REM

BIS / Sedline:

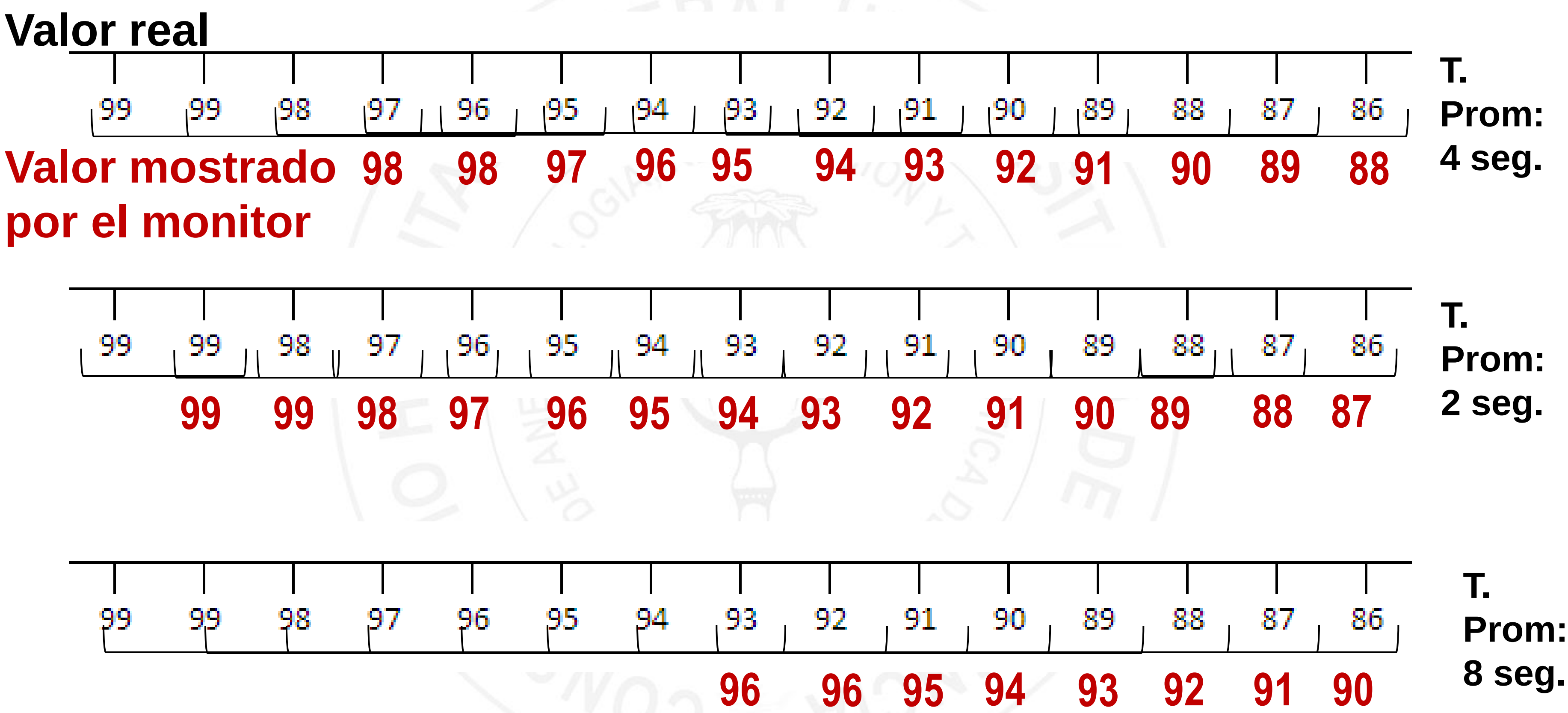
- Indice artificial y empírico que se basa en variables de EEG procesado
- Datos que se contrastan con una biblioteca de pacientes reales para dar un valor de BIS o PSI que se corresponda con el estado hipnótico del paciente

BIS / Sedline:

Tiempo de cálculo depende de :

- Actualización del valor: BIS y Sedline refrescan el nº cada 1-1,2 seg
- Tiempo promedio del cálculo: en cada medición se realiza la media con “x” segundos anteriores:
  - -BIS 45-60 seg según el módelo
  - -Sedline 25 seg (capaz de captar más valores pico y valle, da más variabilidad a la cifra)

Tiempo promedio de calculo



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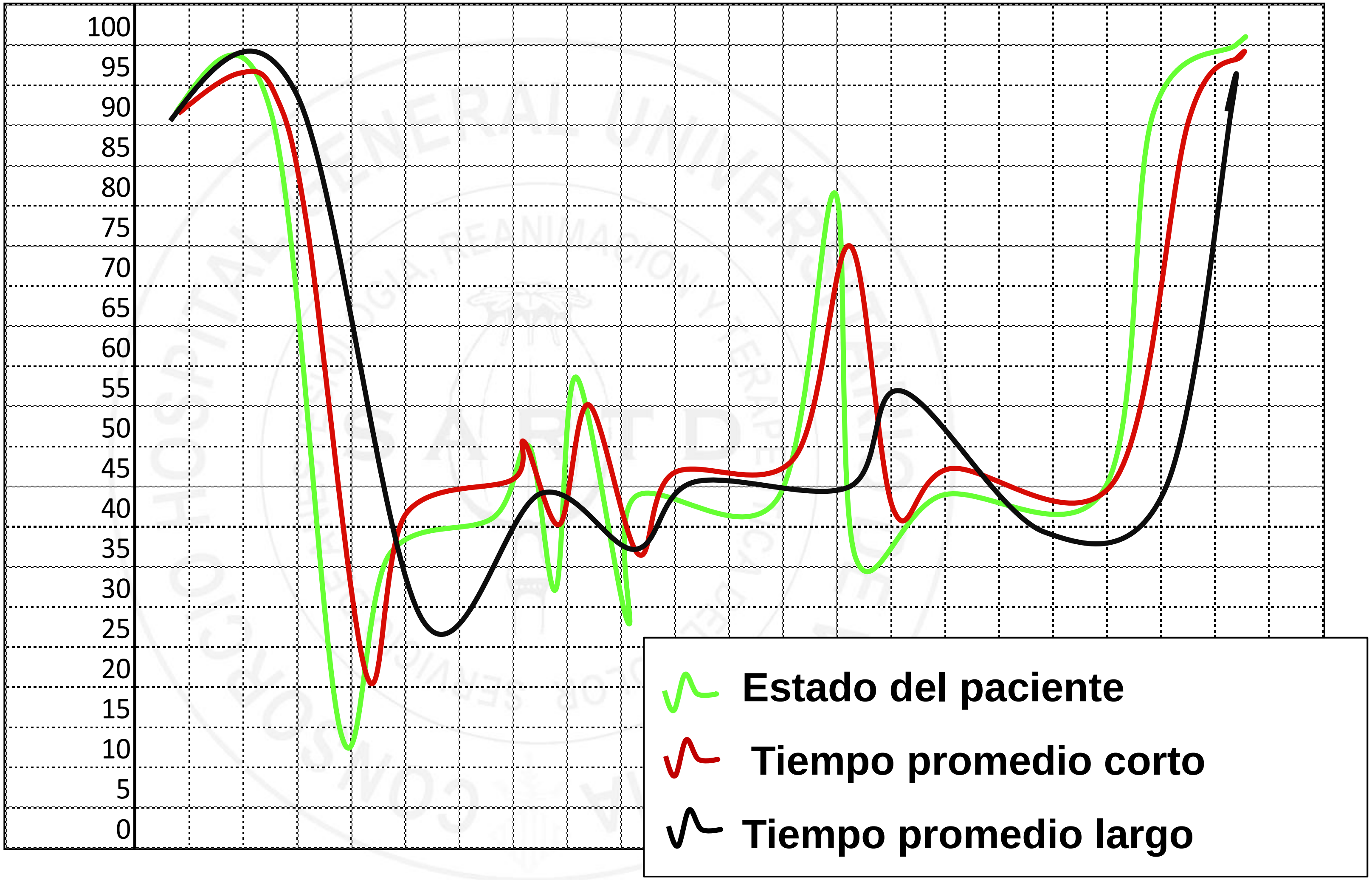
A mayor tiempo promedio……



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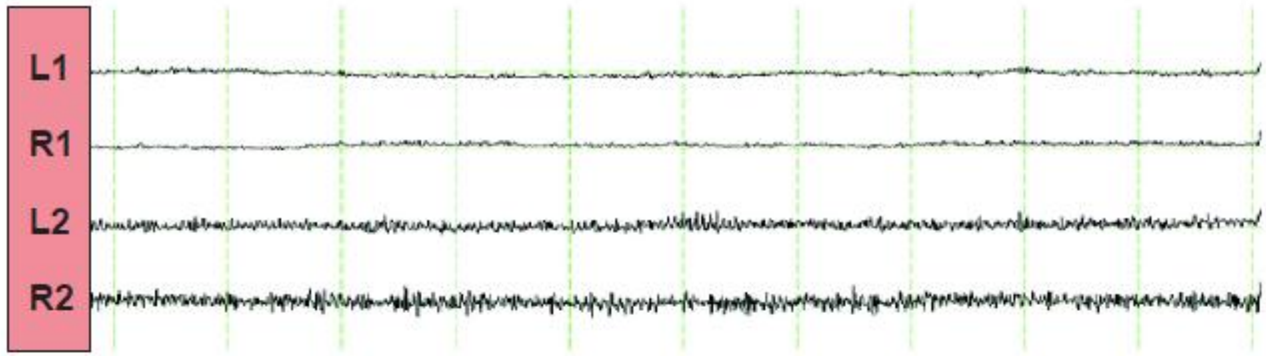
Valencia 21 de Enero de 2014

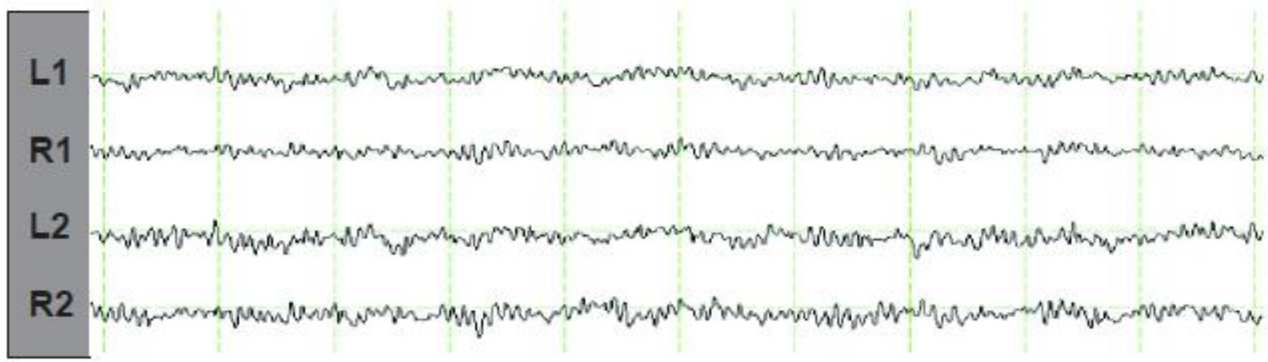
Características de los EEG

- Funciones de un EEG
  - Frecuencia
  - Amplitud
  - Ritmos de EEG
    - Delta
    - Theta
    - Alfa
    - Beta

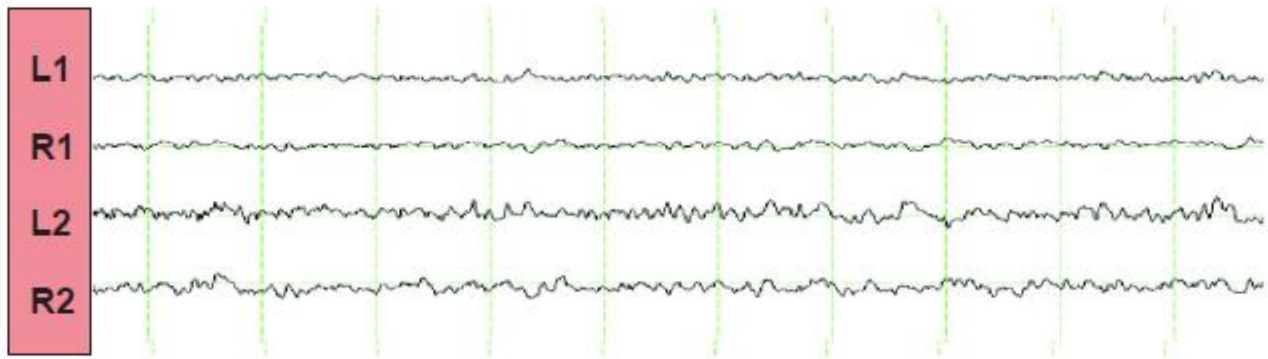
Beta (>13 Hz)



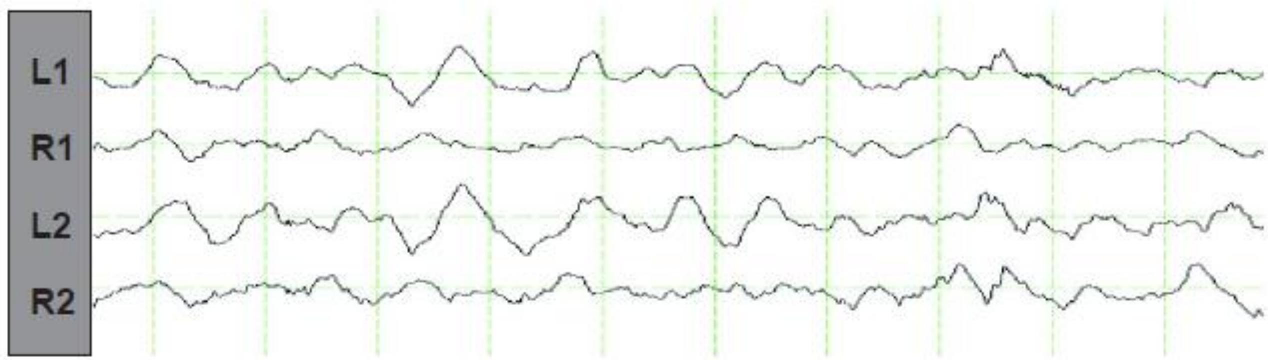
Alfa (8-12 Hz)



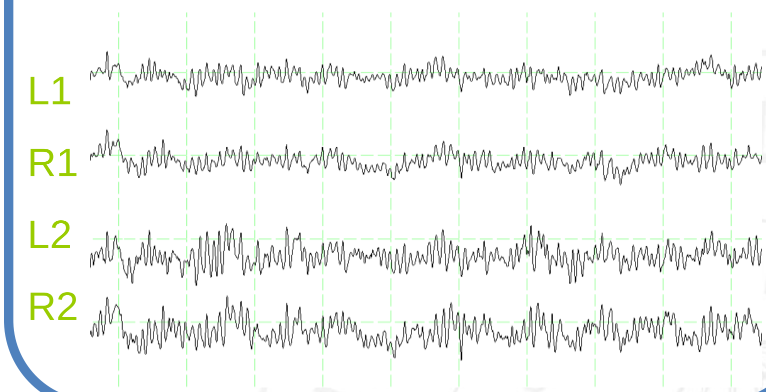
Zeta (4-8 Hz)



Delta (0-4 Hz)

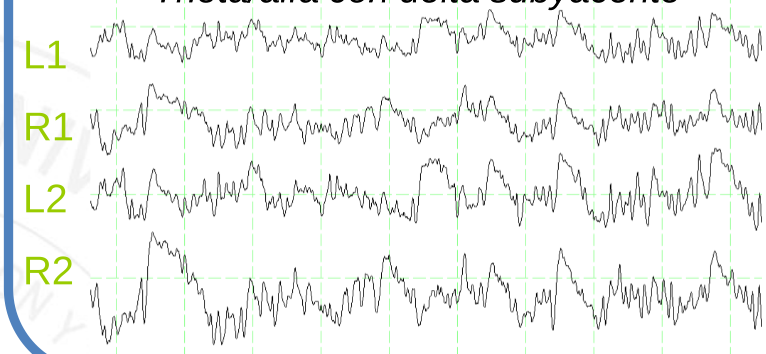


Sedación adecuada

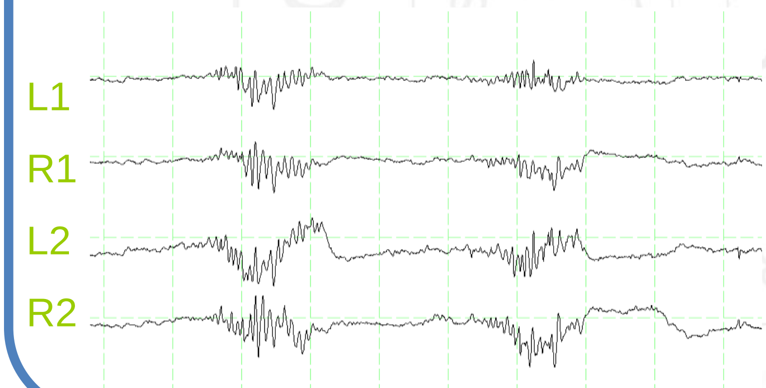


Sedación adecuada

Theta/alfa con delta subyacente



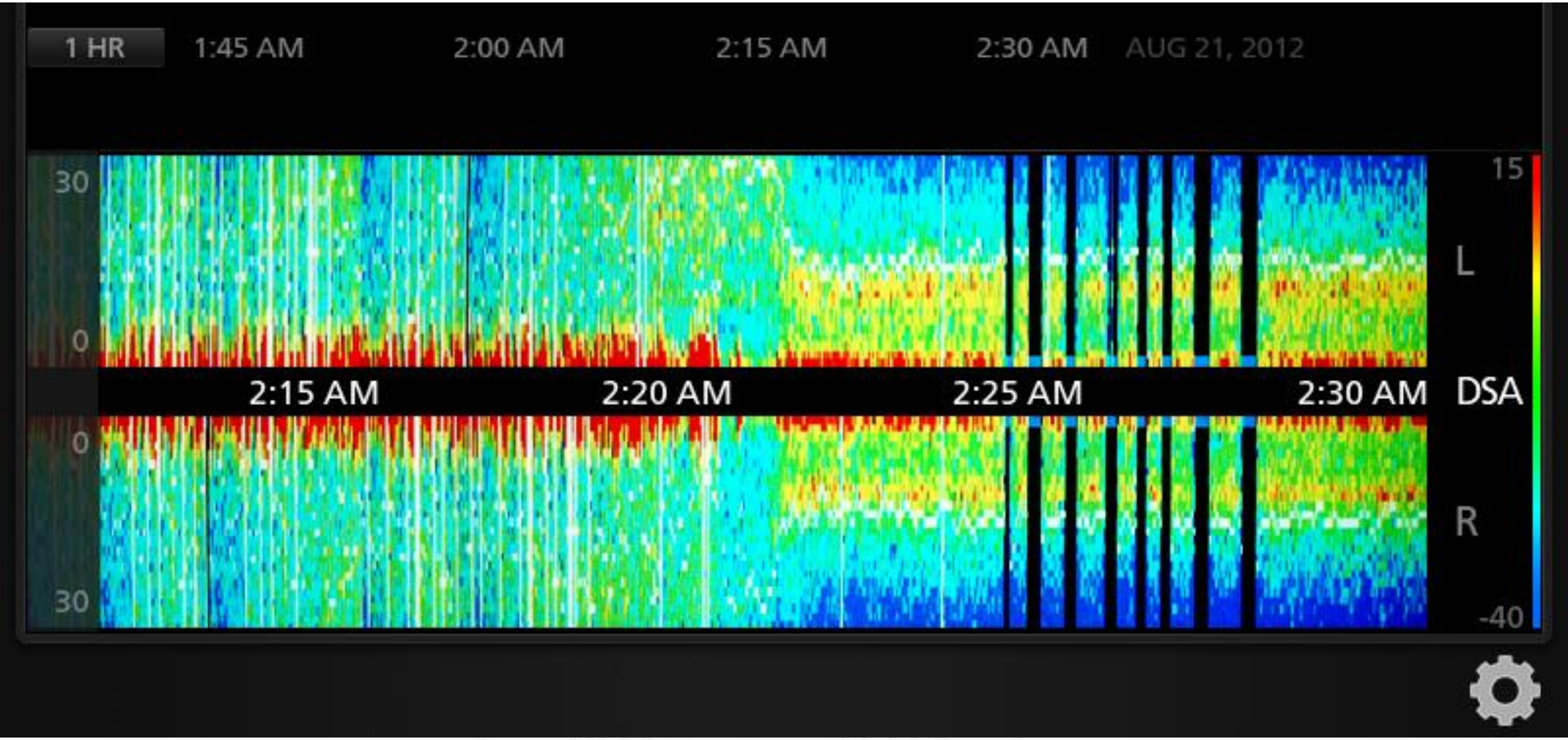
Supresión de ráfaga



Supresión de ráfaga

- Se ve como suena.
- Ráfagas de actividad, seguidas por onda de supresión (plana, isoeléctrica).
- Se ve en los casos de hipotermia y durante los procedimientos de revascularización.
- Se ve en algunas neurocirugías.
- Es indicativo de un nivel de sedación muy profundo.

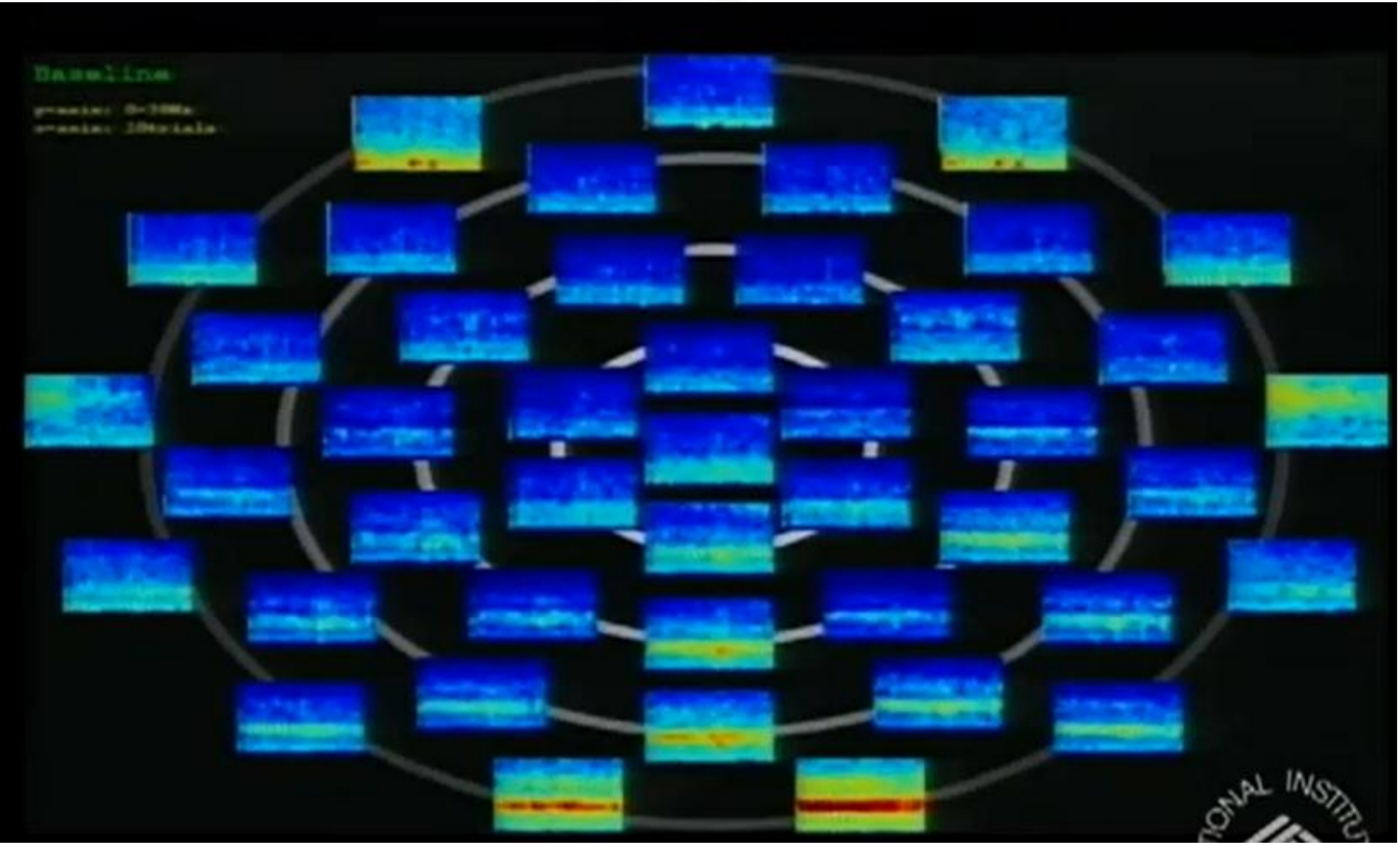
Pantalla DSA



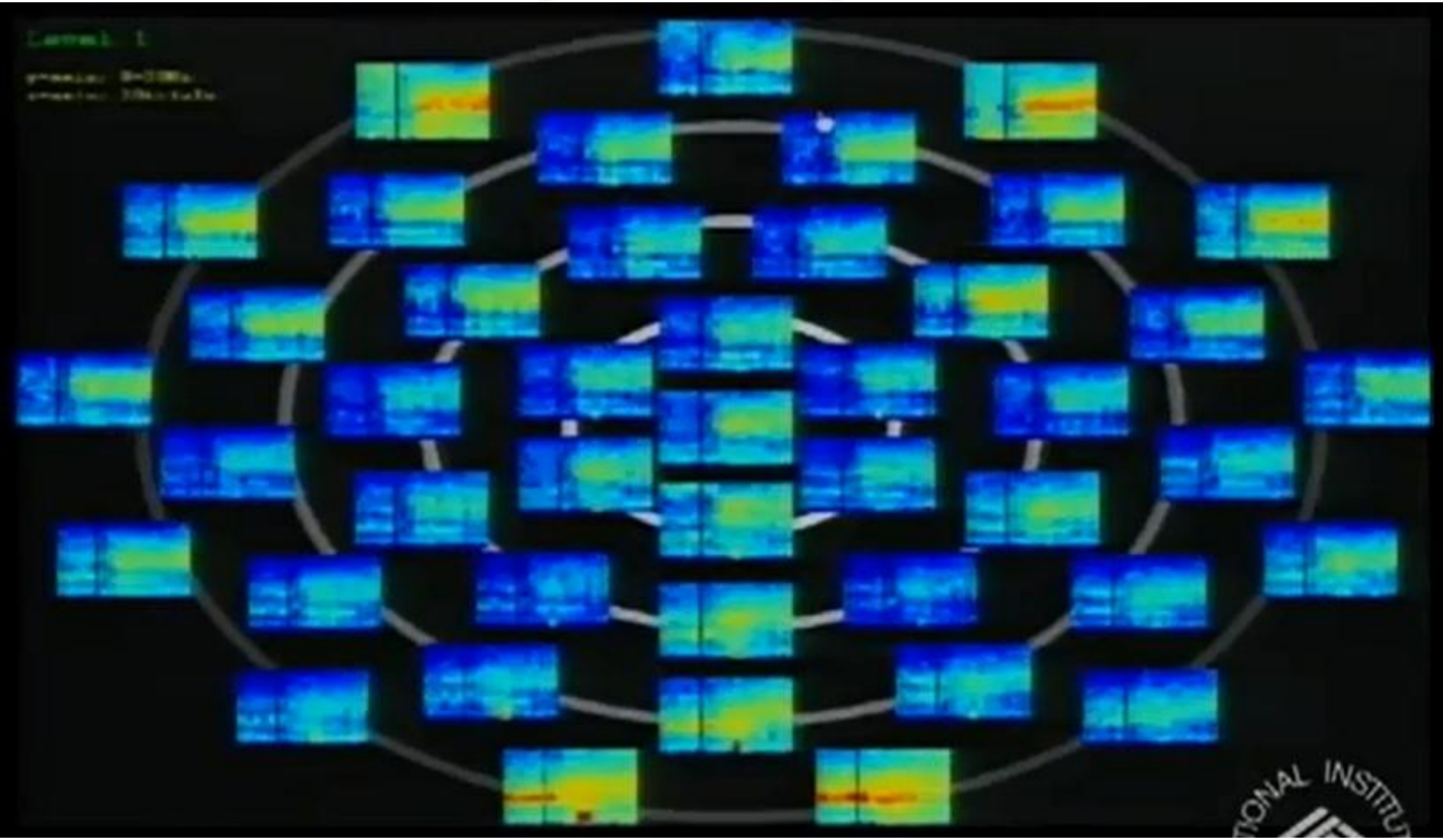
SARTD-CHGUV Sesión de Formación Continuada
Valencia 21 de Enero de 2014

Transición Frontal - Consciente ojos cerrados

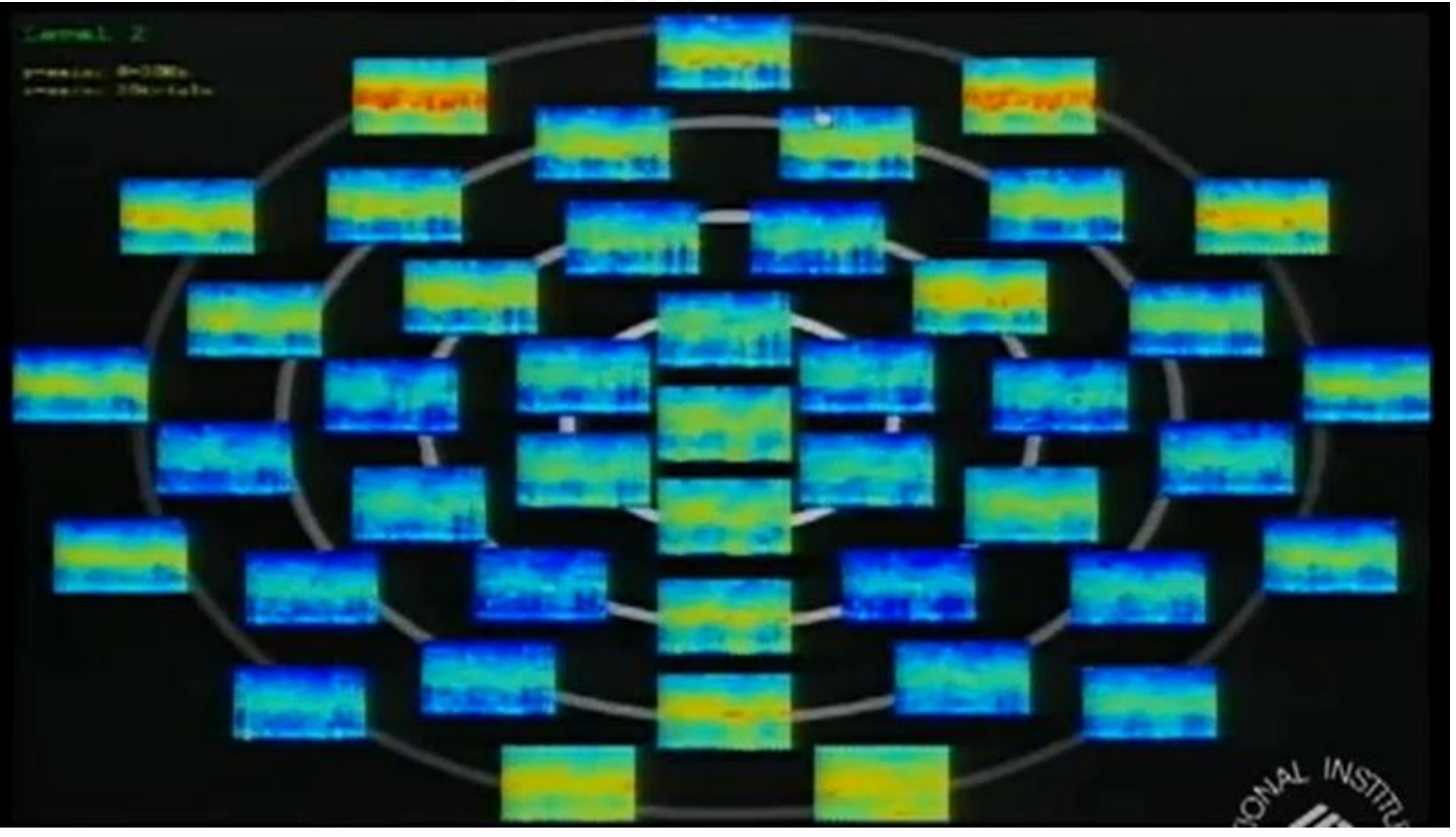
Fuente Imágenes : Dr. Emery N. Brown, MD, PhD. Mass Gen. Hospital, Prof. Anesthesia Harvard Medical School, Department of Brain and Cognitive Sciences at MIT.



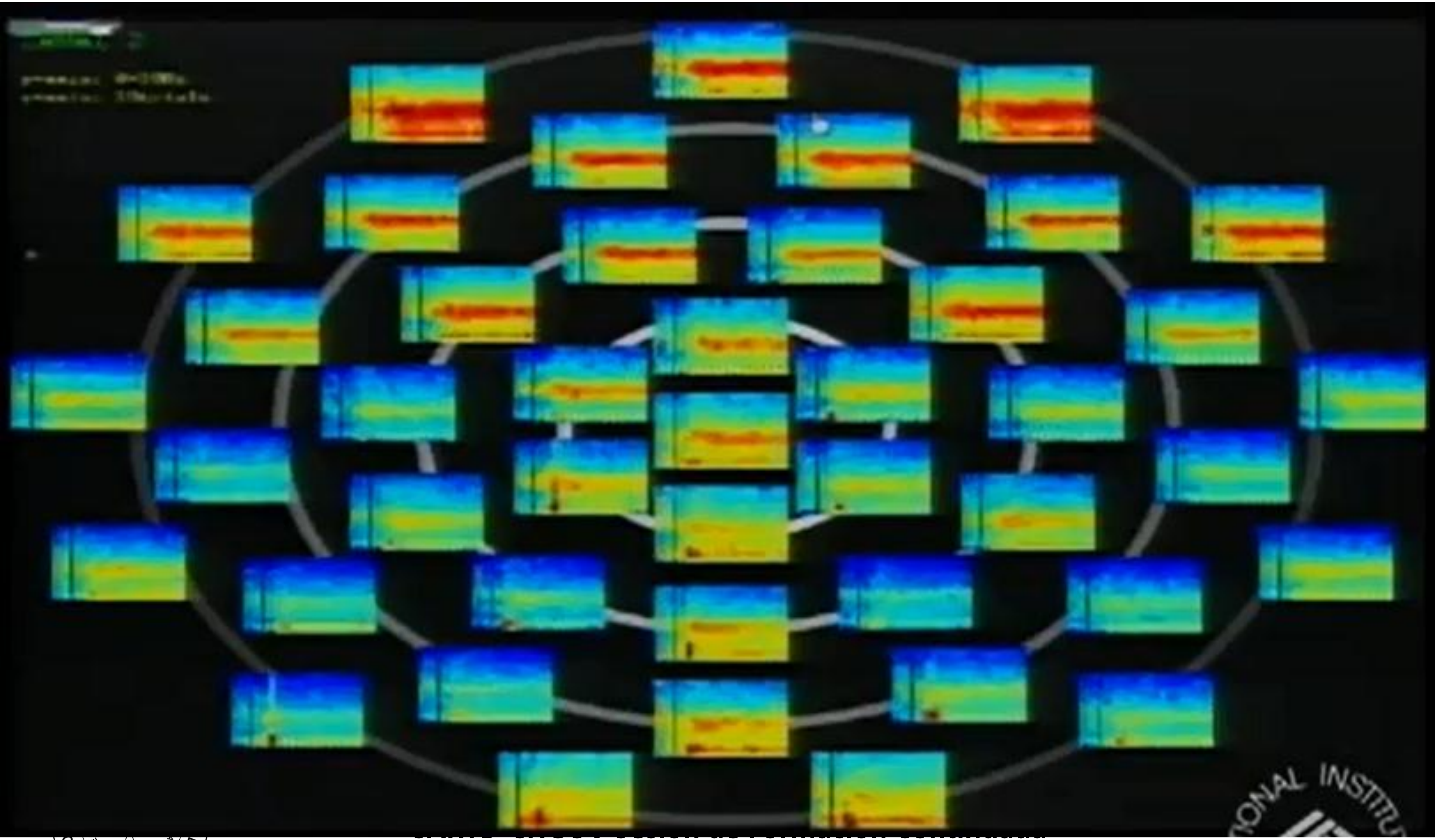
Transición Frontal - Inducción



Transición Frontal - Estado hipnótico superficial

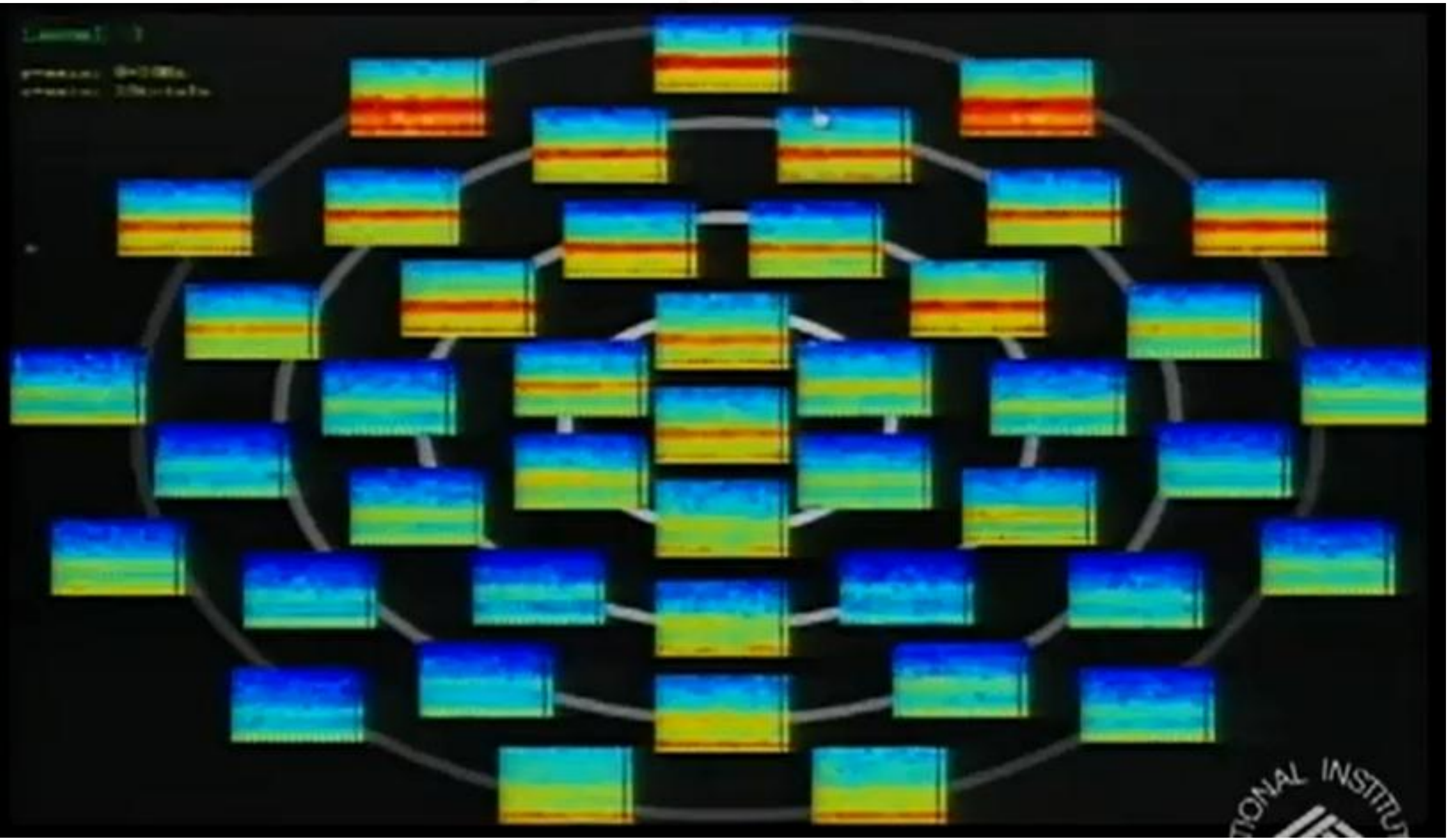


Transición Frontal - Profundizando

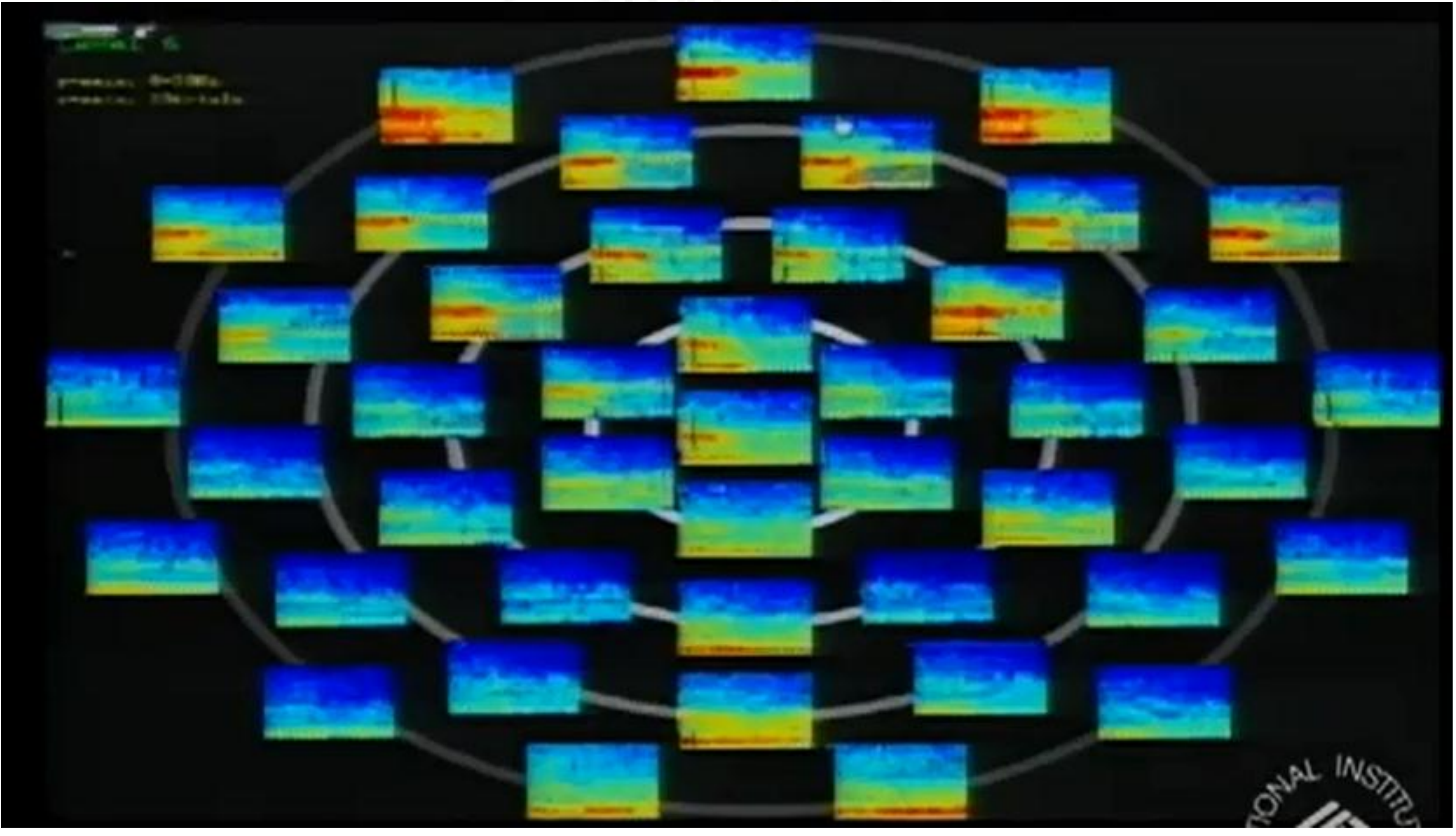


Fuente Imágenes : Dr. Emery N. Brown, MD, PhD Mass General Hospital, Prof. Anesthesia Harvard Medical School, Department of Brain and Cognitive Sciences at MIT.

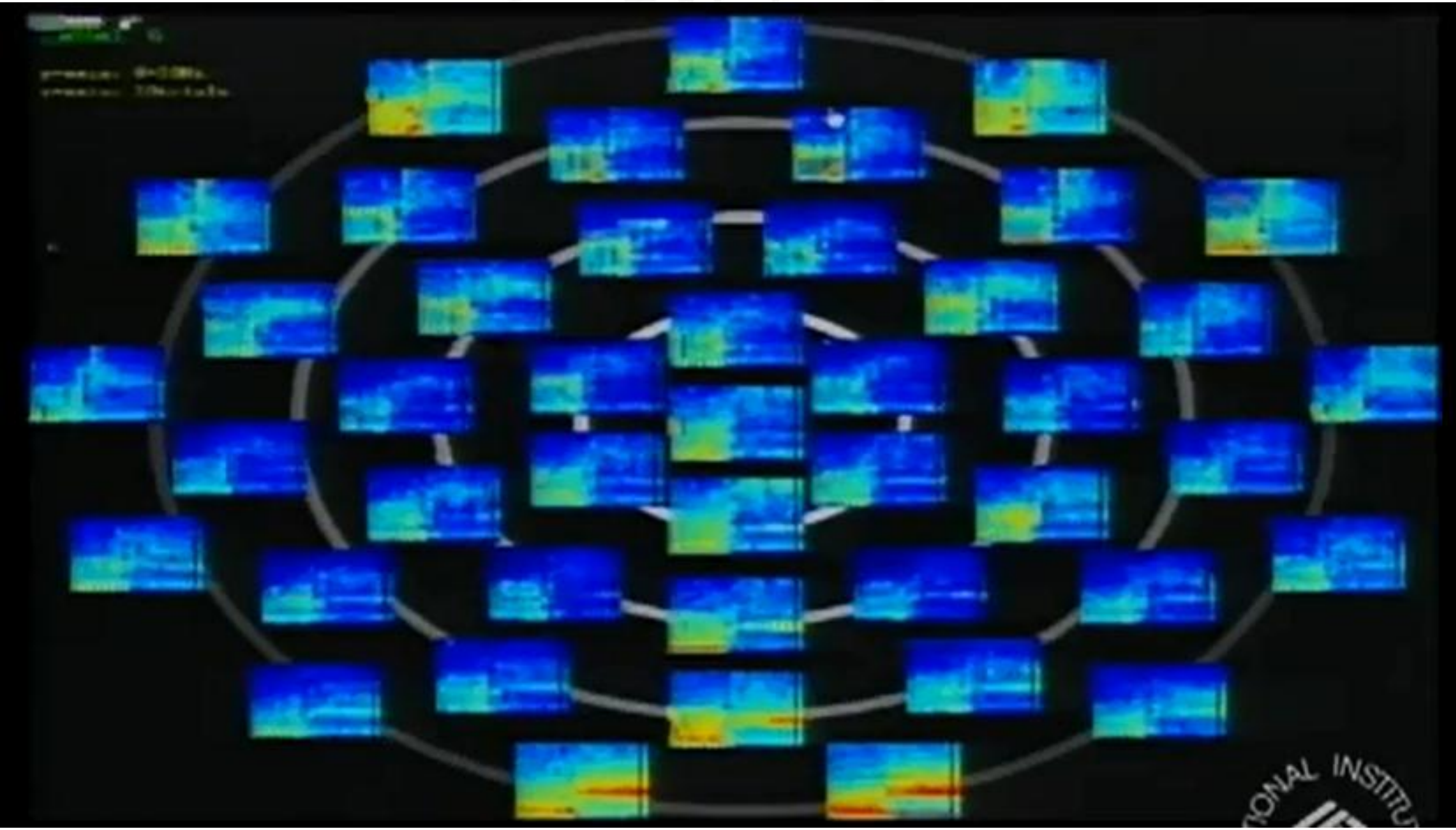
Transición Frontal - Estado hipnótico profundo



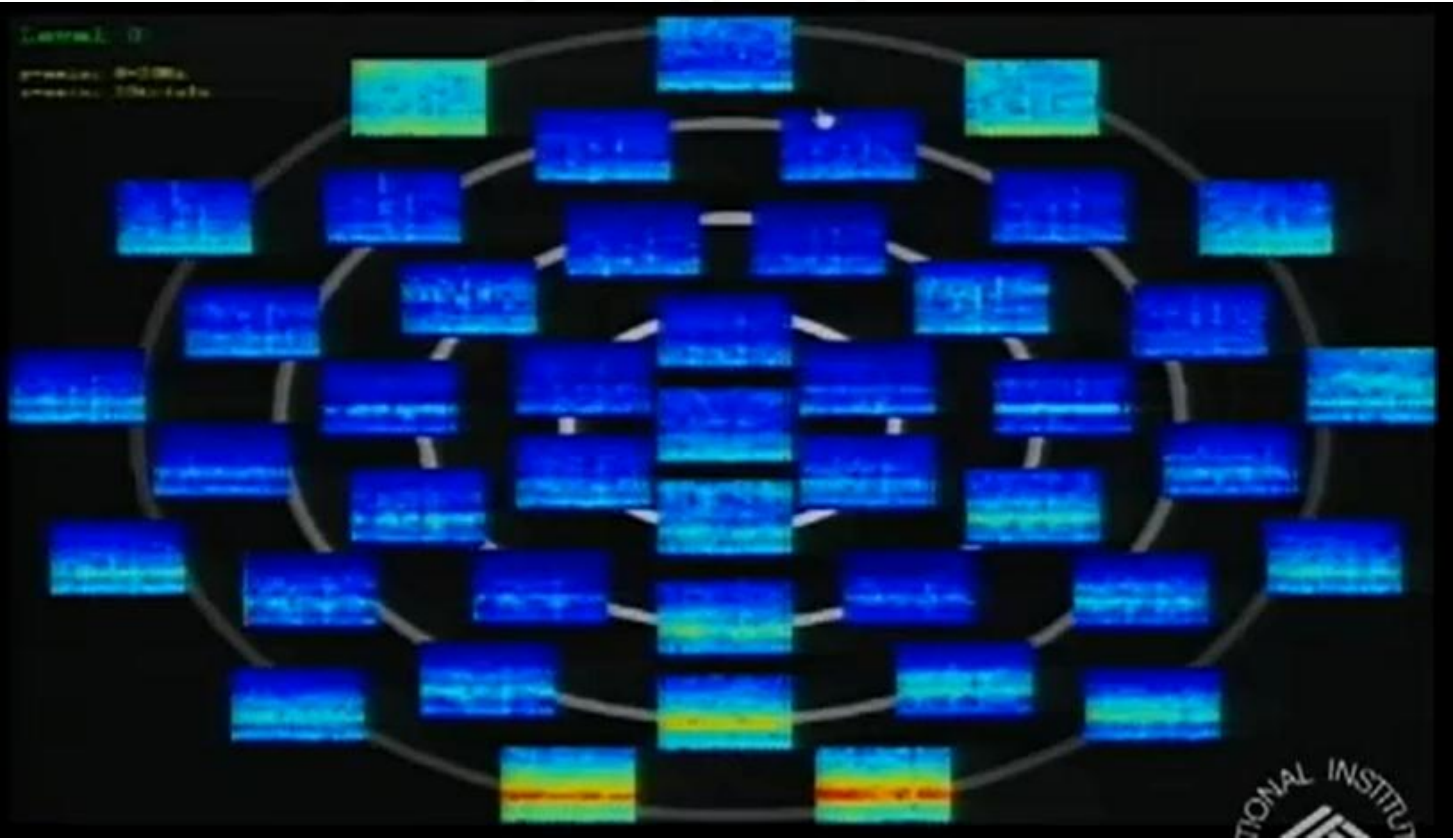
Transición Frontal - Superficializando

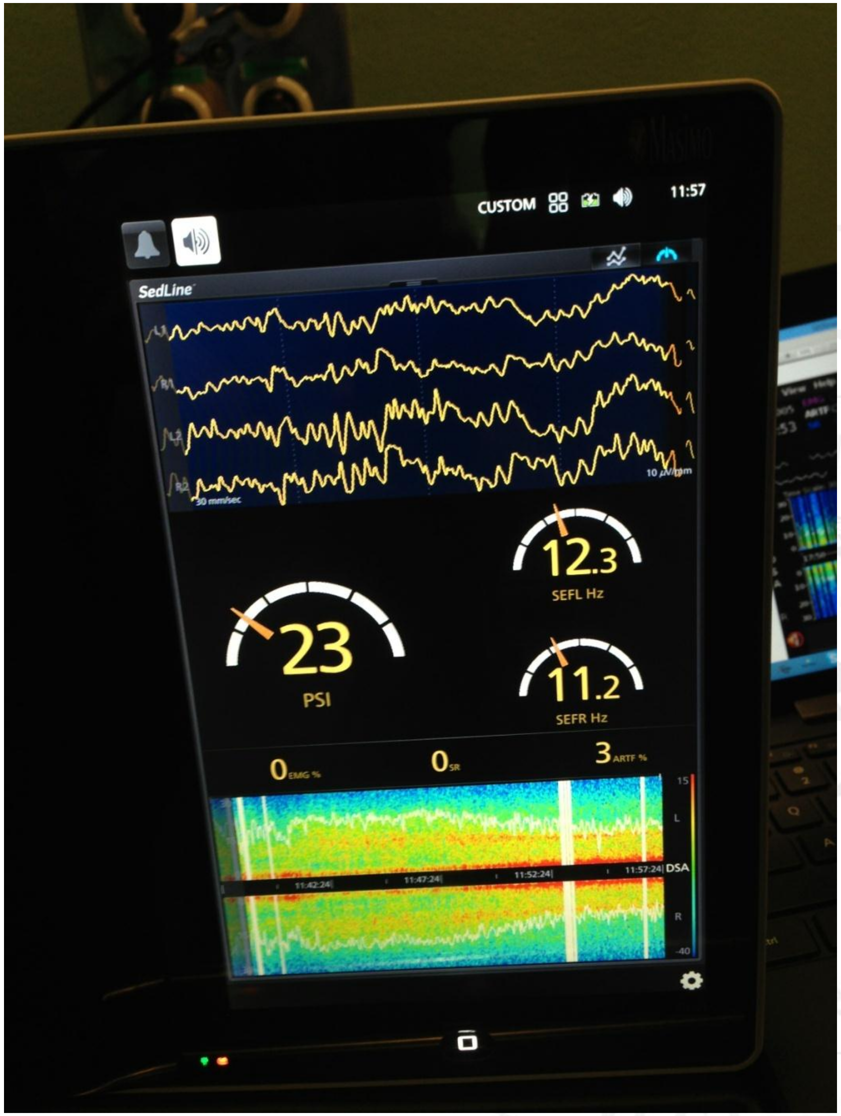


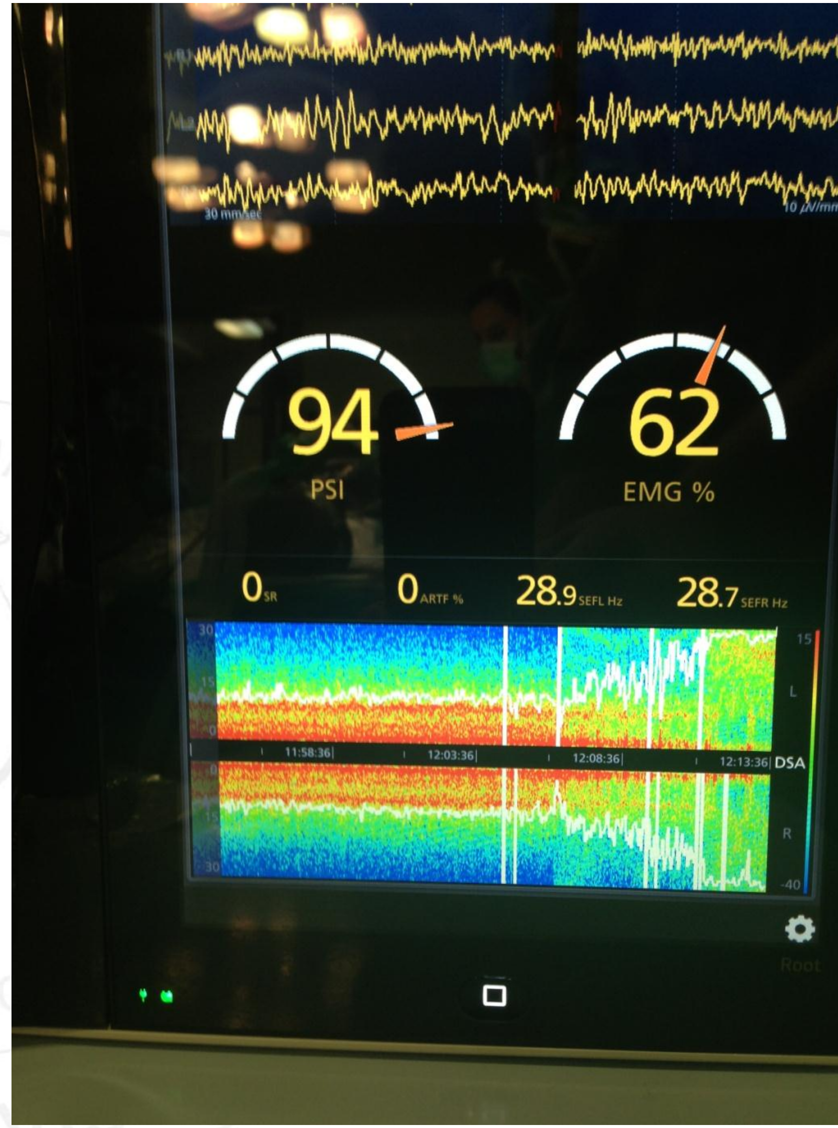
Transición Frontal - Despertando



Transición Frontal - Consciente ojos cerrados





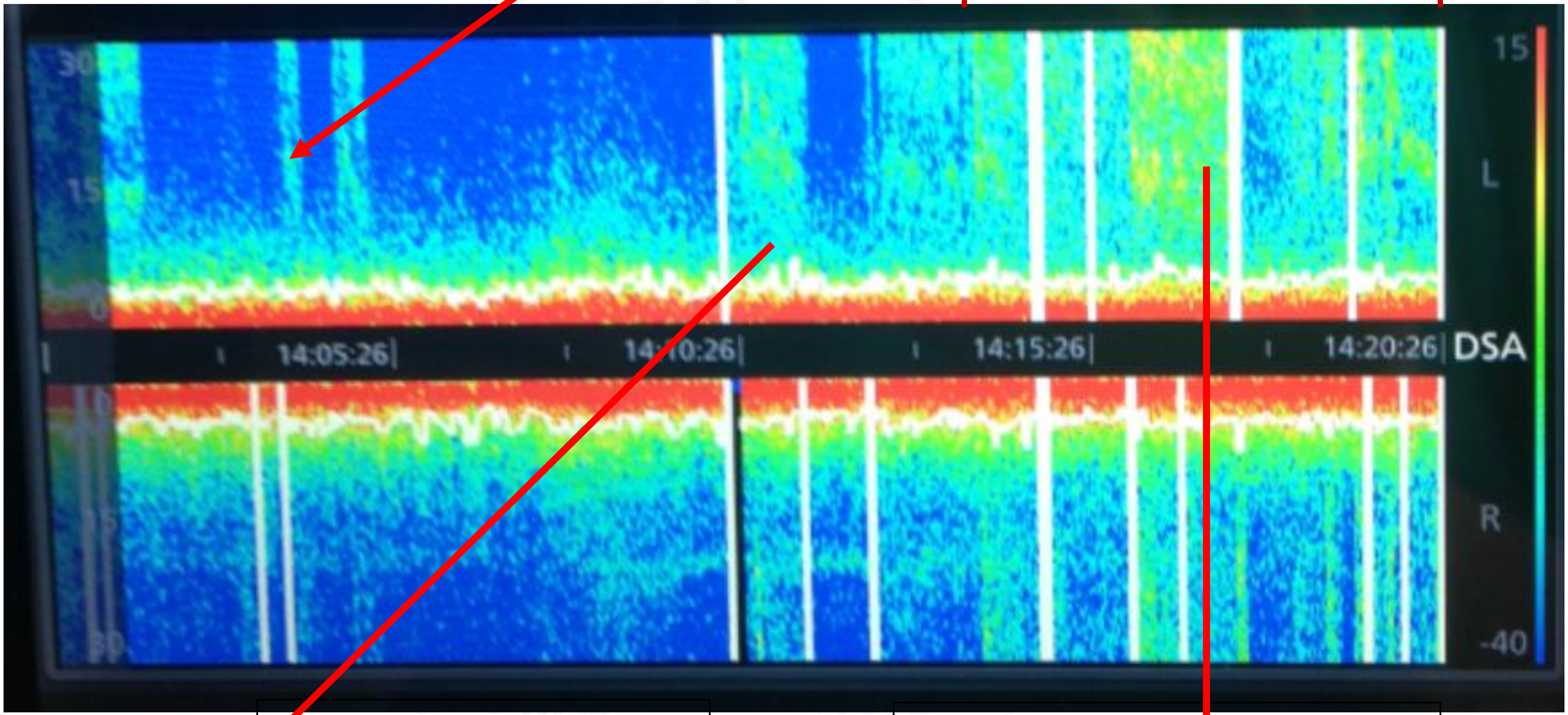


SARTD-CHGUV Sesión de Formación Continuada

Valencia 21 de Enero de 2014

Actividad durante toda la mañana: Esporádicos aumentos de actividad no muy intensos tanto espontaneos como en respuesta a estímulos dolorosos

La actividad cerebral aumenta en el momento que la familia le toca y habla con el paciente



La familia entra en la habitación

La familia toca al paciente y empieza a hablarle

EEG/BIS/SEDLINE en UCC y quirófano

- 1. <u>Evaluación continua</u>. Primera señal de deterioro neurológico. Detección de actividad convulsiva silente. Primer indicio de muerte cerebral. Monitorización de la hipnosis.
- 2. <u>Coma inducido por fármacos</u>. Asegurar EEG sin actividad: parada circulatoria, dosificación de thiopental
- 3. Valoración objetiva de la <u>sedación</u> durante procedimientos invasivos.
- 4. Cuidados al <u>final de la vida.</u>

Crit Care Med 1999;27(8)
Anesthesiology 1999;91(3A)
The Annals of Pharmacotherapy 2006 (40)
GuQ 2007; 19(2)
Masui 2007;56(1)
Am J Emerg Med 2004; 22(2)
Anesth Analg 2005; 101(4)
Ann Fr Anesth Reanim 2004; 23(5)
Crit Care Med 2005 33(3)
Chest 2005;128:303-7