1ST RESIDENTIAL TRAINING COURSE of the ESNCH

European Society of Neurosonology and Cerebral Hemodynamics

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CEREBRAL CIRCULATORY ARREST

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BRAIN DEATH IS THE IRREVERSIBLE LOSS OF FUNCTION OF THE ENTIRE BRAIN INCLUDING THE BRAIN STEM

Conventional Confirmatory Tests:
EEG, CEREBRAL AGF, BRAIN SCINTIGRAPHY

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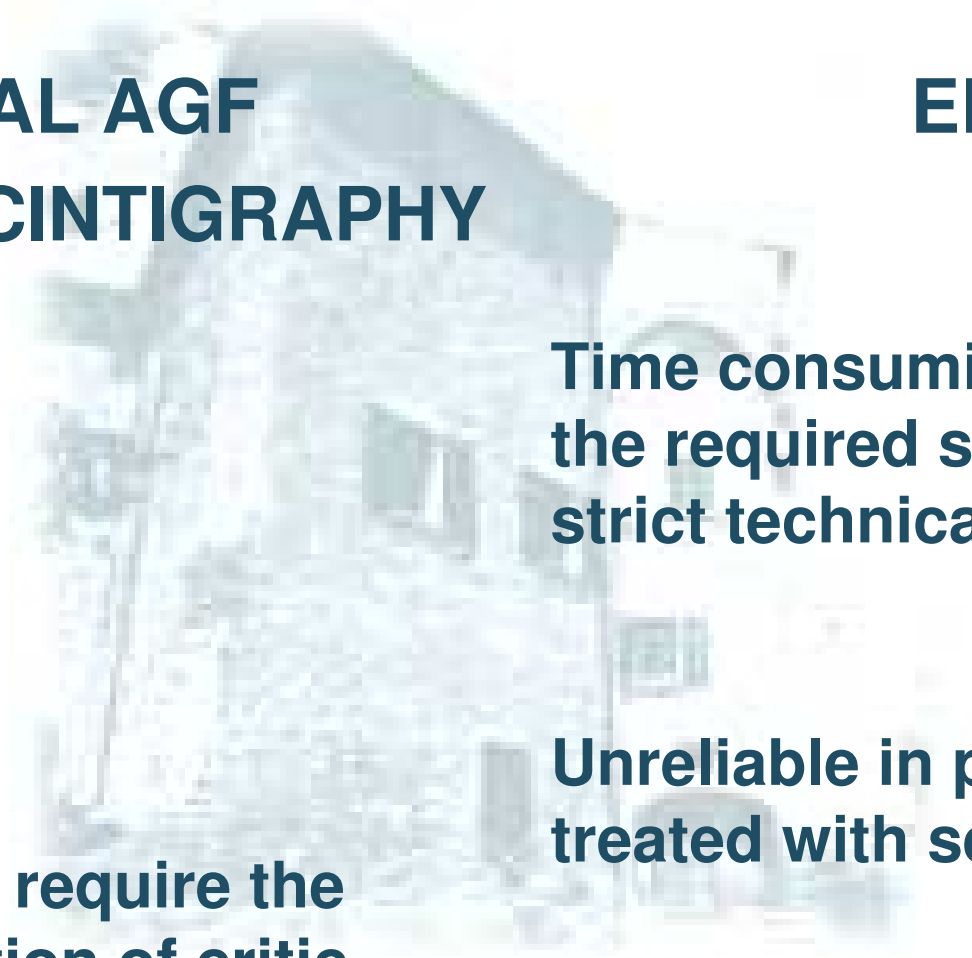
LOGISTICAL PROBLEMS

TCD evaluation is used in several countries as a confirmatory test to assess CBF arrest

DISADVANTAGES OF CONVENTIONAL CONFIRMATORY TESTS



CEREBRAL AGF

BRAIN SCINTIGRAPHY

Invasive

Expensive

Commonly require the transportation of critic patients

EEG

Time consuming because of the required setup time and strict technical standards

Unreliable in patients treated with sedative drugs

Computed tomographic angiography for diagnosis of brain death

Adnan I. Qureshi, MD; Jawad F. Kirmani, MD; Andrew R. Xavier, MD; and Amir M. Siddiqui, MD

Abstract—The authors report two patients with suspected brain death who required confirmatory tests other than clinical examination because of prolonged barbiturate administration for intracranial hypertension. Absence of intracranial blood flow was documented on CT angiography and confirmed by CT perfusion images. Cerebral angiography confirmed the findings consistent with brain death. CT angiography with CT perfusion may represent a rapid noninvasive method for diagnosis of brain death.

NEUROLOGY 2004;62:652–653

Diagnóstico de muerte encefálica mediante tomografía computarizada multicorte: angio-TC y perfusión cerebral

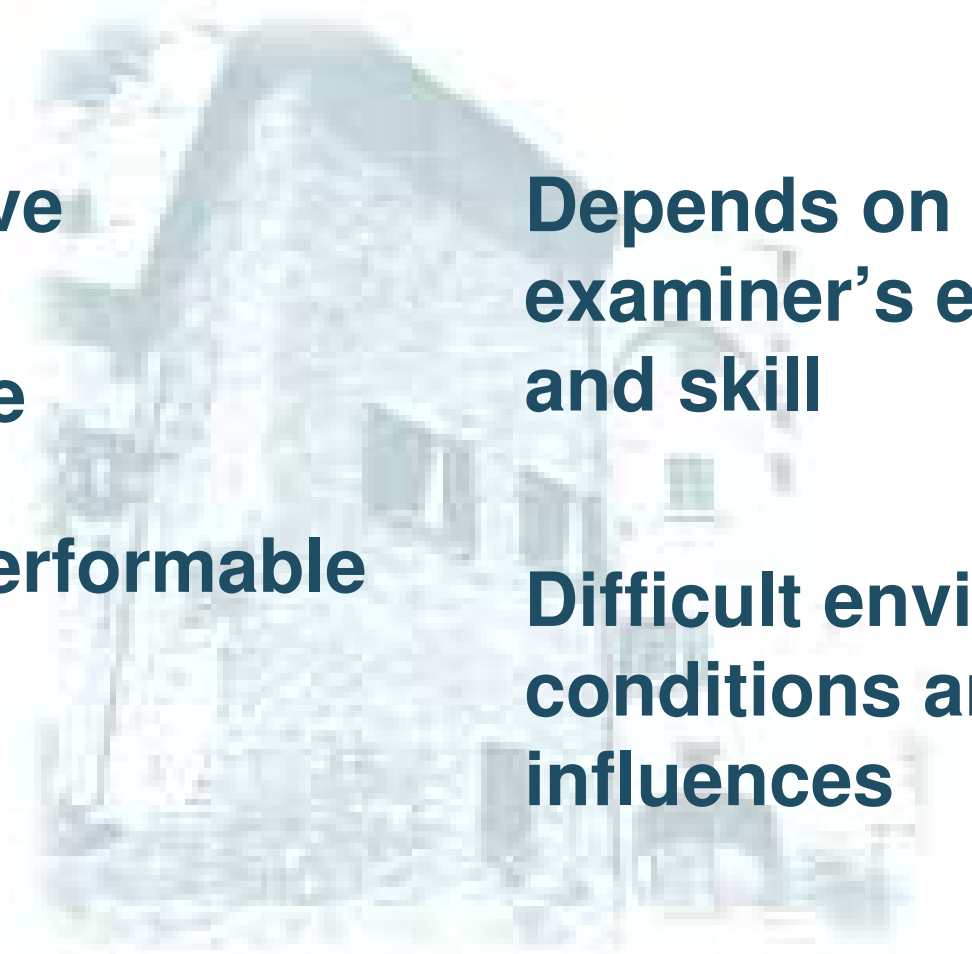
D. ESCUDERO[a], J. OTERO[a], P. VEGA[b], A. GIL[b], R.L. ROGER[b], J.A. GONZALO[a], G. MUÑIZ[a] Y F. TABOADA[a]

[a]Servicio de Medicina Intensiva. [b]Servicio de Radiología. Hospital Universitario Central de Asturias. Oviedo. Asturias. España.

Med Intensiva. 2007;31(6):335-41

TCD

ADVANTAGES	*DISADVANTAGES*
Non-invasive	Depends on the examiner's experience and skill
Inexpensive	
Bed-side performable	Difficult enviromental conditions and outside influences
Repeatable as often as needed	IAW (8-9%)



Article abstract—Transcranial Doppler examinations (TCD) of 24 brain-dead adult patients demonstrated persistent movement of blood within the middle cerebral arteries in 21. The characteristic pattern of Doppler shift frequencies, seen in 14, was a sharply contoured, brief anterograde systolic envelope with reversed diastolic flow. Five others had variants of this pattern, and two had anterograde flow throughout the cardiac cycle, except at the end of diastole. This suggests that the internal carotid and proximal middle cerebral artery circulation remains patent, but distal resistance to flow in the brain is very high in the majority of brain-dead patients. Three other patients with absent brainstem reflexes but persistent EEG activity had normal TCD patterns. The characteristic pattern on TCD may be a useful ancillary finding in the diagnosis of brain death, and normal TCD patterns probably exclude the diagnosis.

NEUROLOGY 1987;37:1733-1735

Transcranial Doppler in brain death

Allan H. Ropper, MD; Susan M. Kehne, MD; and Larry Wechsler, MD

J Neurosurg. 1989 Aug;71(2):195-201.

Transcranial Doppler study of intracranial circulatory arrest.

Hassler W, Steinmetz H, Pirschel J.

Department of Neurosurgery, University of Tubingen, West Germany.

To investigate the hemodynamics of intracranial circulatory arrest, the authors correlated the findings of noninvasive transcranial Doppler ultrasonography (TCD) with those of transfemoral four-vessel angiography in 65 patients following brain death and intracranial circulatory arrest due to severe intracranial hypertension. The three TCD stages of intracranial circulatory arrest, which have been described previously, corresponded with different levels of extracerebral angiographic cessation of flow. With TCD progression from the first stage (oscillating flow) to the third stage (no flow), the level where the dye stopped descended caudad from subarachnoid to cervical levels. The study shows that, in progressing intracranial hypertension, arterial circulatory standstill within the cranial cavity develops in a distal-to-proximal direction. The basal cerebral arteries remain patent in the early stages of intracranial circulatory arrest. Experimental evidence from the literature, together with the findings of the present investigation, points to the capillary bed as the initial site of the flow obstruction in progressing intracranial hypertension.

Journal of the Neurological Sciences
Volume 159, Issue 2 , 14 August 1998, Pages 145-150

Consensus opinion on diagnosis of cerebral circulatory arrest using Doppler-sonography

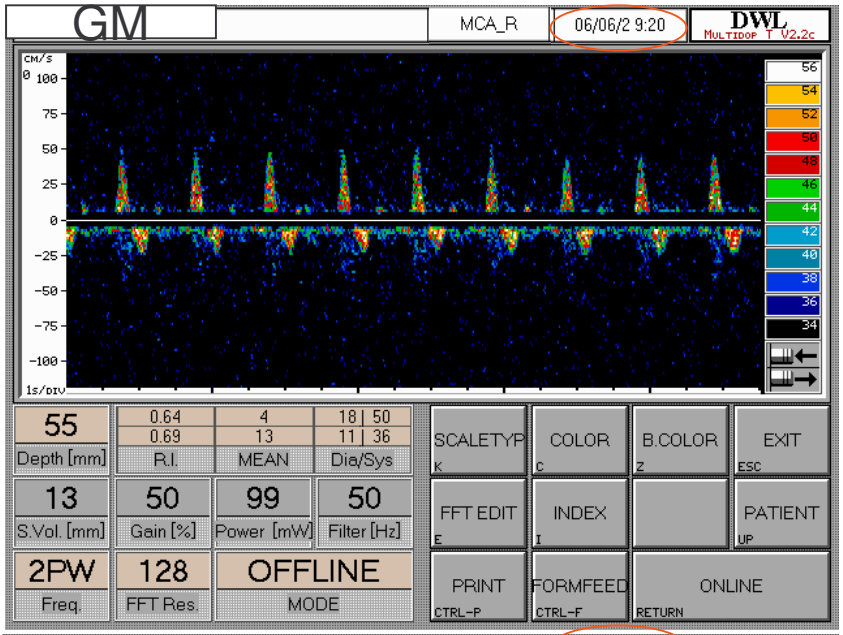
Task Force Group on cerebral death of the Neurosonolgy Research Group of the World Federation of Neurology

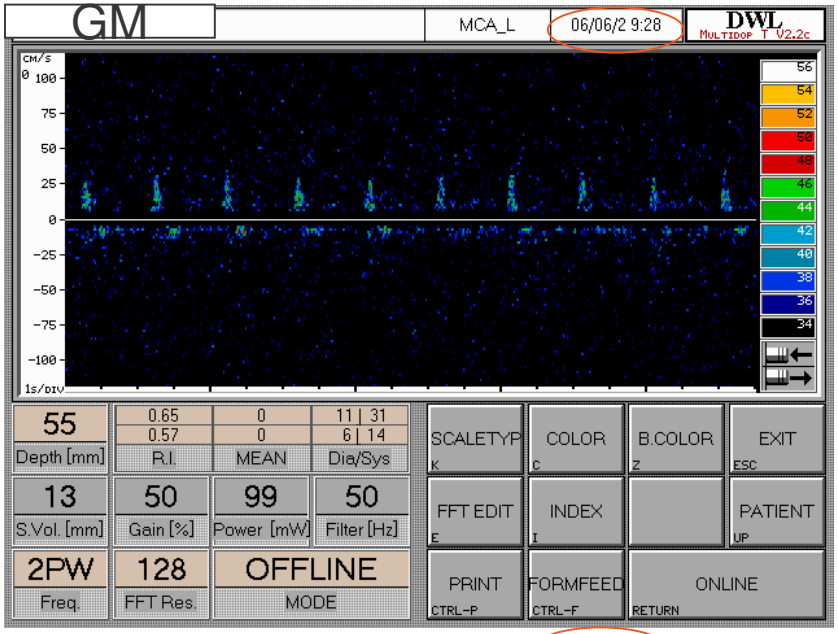
Xavier Ducrocq[a], Werner Hassler[b], Kouzo Moritake[c], David W. Newell[d], Gerhard-Michael von Reutern[e], [*] Toshiyuki Shiogai[f] and Robert R. Smith[g]

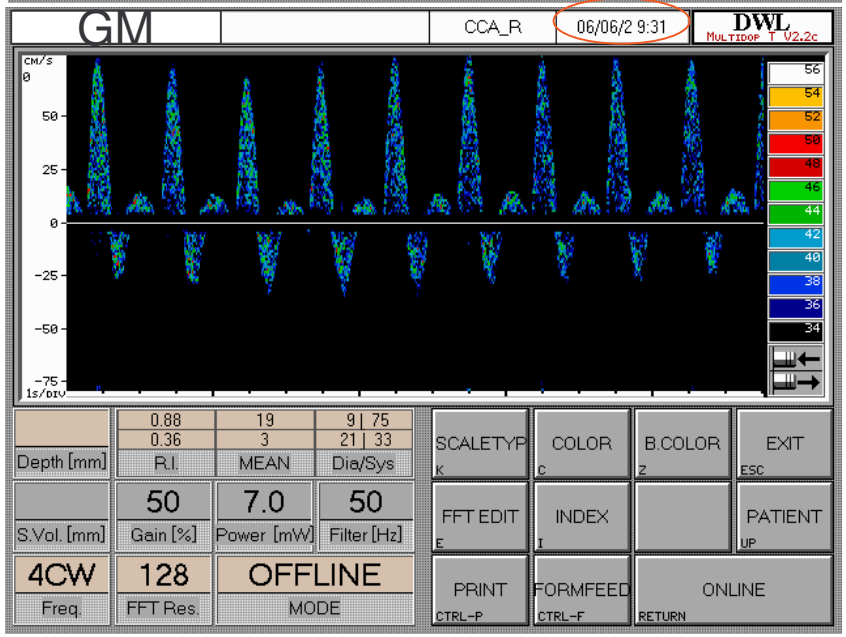
"Extracranial and intracranial Doppler Sonography are useful confirmatory tests to establish irreversibility of cerebral circulatory arrest as an optional part of brain death protocol"

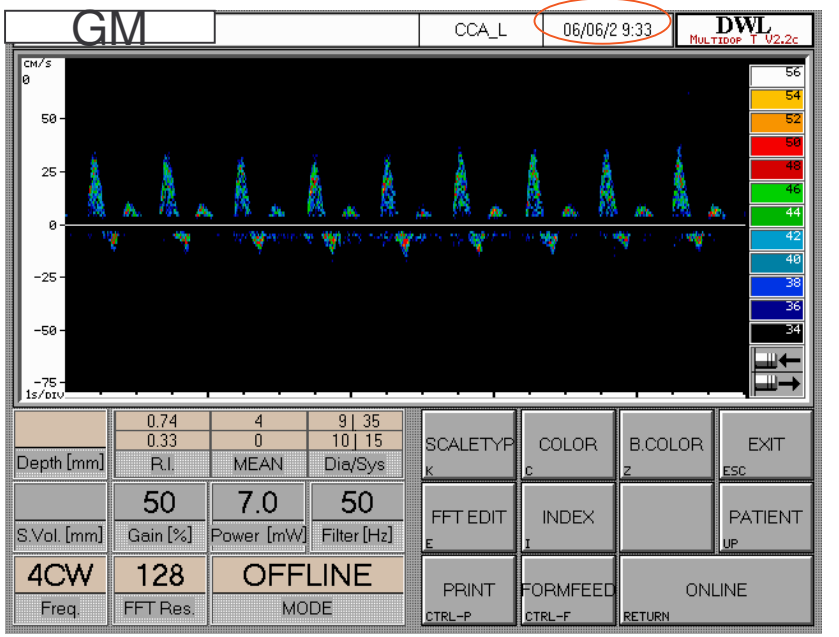
"Doppler-sonography is of special value when therapeutic use of sedative drugs renders EEG unreliable"

TCD PATTERN OF CEREBRAL CIRCULATORY ARREST IN INTRA-AND EXTRACRANIAL VESSELS









Summary of findings
Increased Intracranial Pressure (ICP) and Cerebral Circulatory Arrest

INDICATION	SENSITIVITY (%)	SPECIFICITY (%)	REFERENCE STANDARD
Cerebral Circulatory Arrest and Brain Death	91-100	97-100	Conventional angiography, EEG, clinical outcome

Recommendation: TCD is a useful adjunct test for the evaluation of cerebral circulatory arrest associated with brain death (Type A*, Class II evidence).

- SENSITIVITY 91-100 %
- SPECIFICITY 97-100%

false negatives due to:

false positives due to:

therapeutic decompressive craniotomy

Complete flow arrest occurring shortly after cardiac arrest in the no reflow phase

ventricular derivation

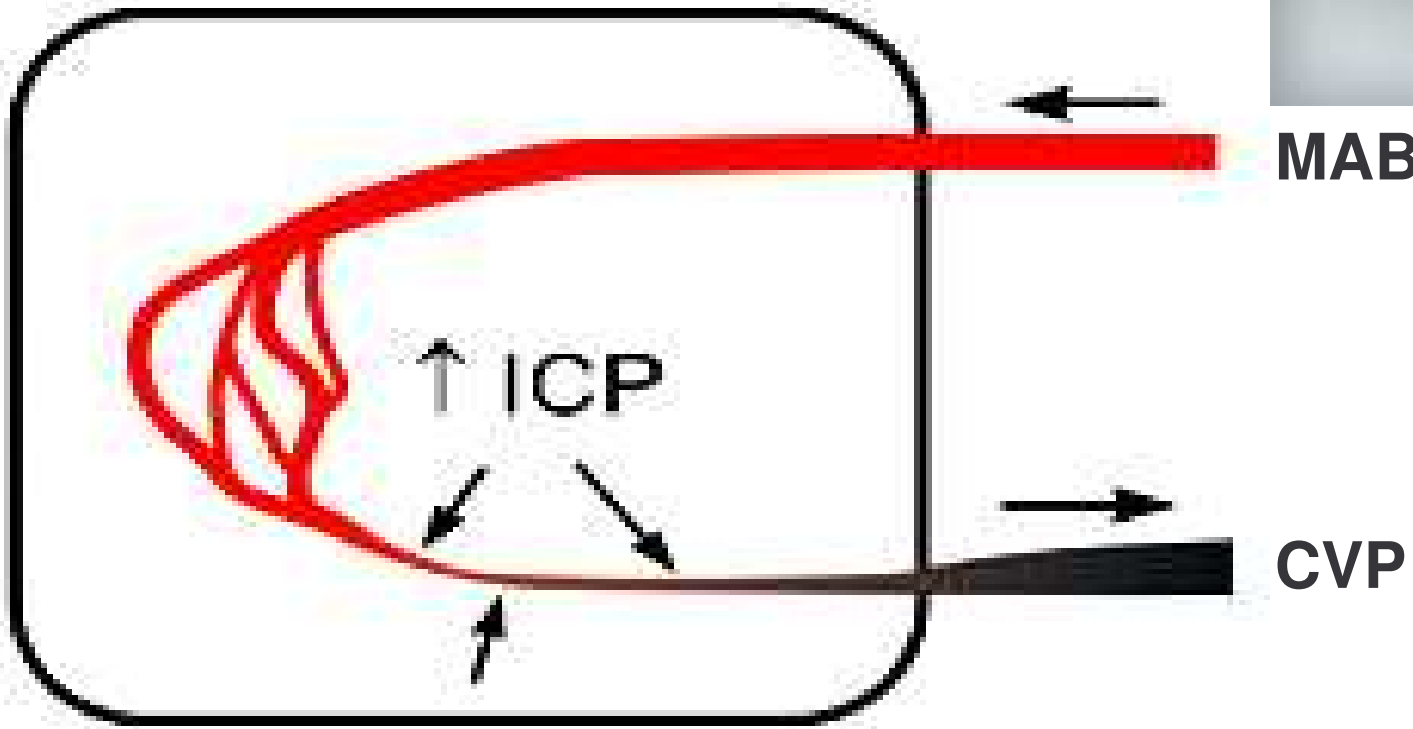
Acute intracranial hypertension due to bleeding from an aneurysm that can be associated with transient flow patterns similar to those in cerebral circulatory arrest

infratentorial brain damage

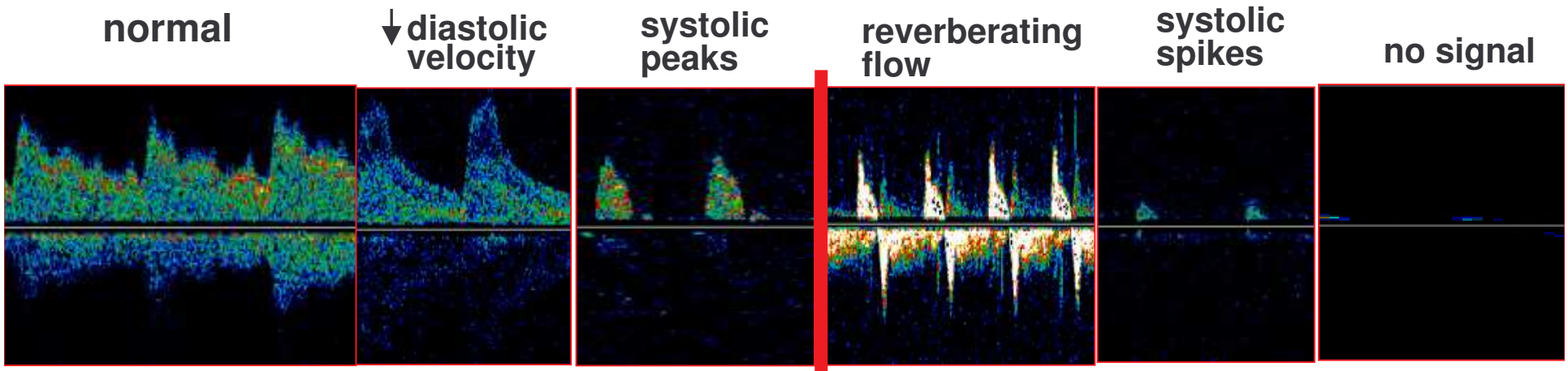
severe cerebral atrophy

PATHOPHYSIOLOGY OF HEMODYNAMIC CHANGES POSSIBLY LEADING TO CEREBRAL CIRCULATORY ARREST

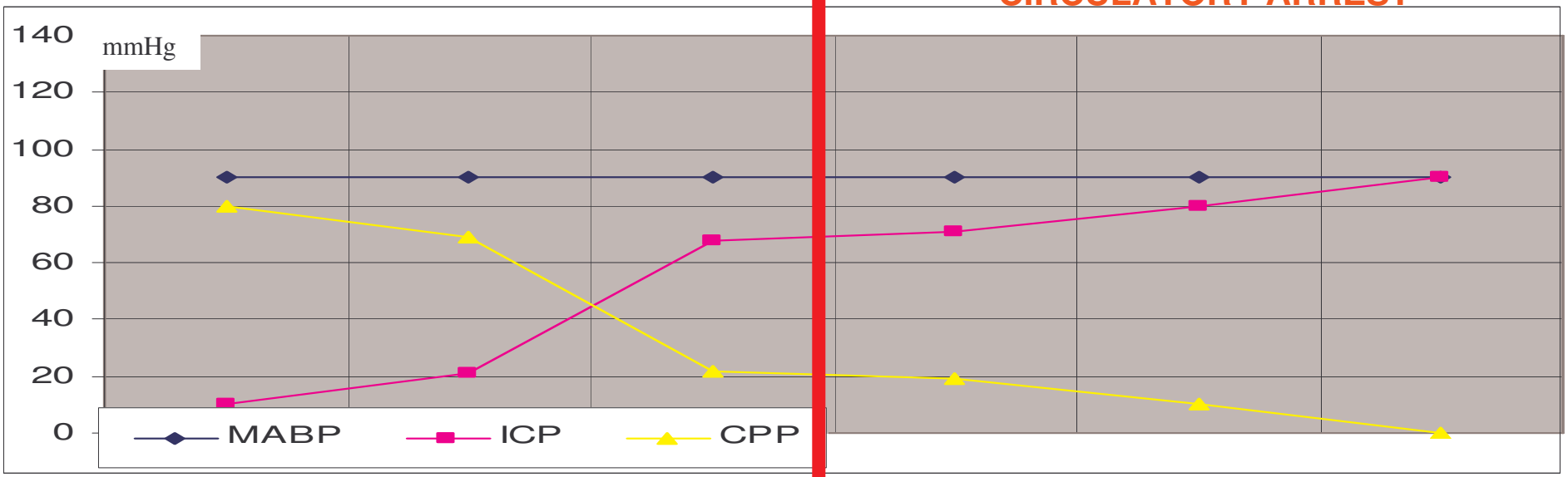
CPP = MABP - ICP



VARIATIONS OF TCD PATTERNS OCCURRING AS INTRACRANIAL HYPERTENSION PROGRESSES TO BRAIN DEATH



IRREVERSIBLE INTRACRANIAL CIRCULATORY ARREST



J Neurol (1999) 246 : 432–437

REVIEW

Walter F. Haupt
Jobst Rudolf

European brain death codes: a comparison of national guidelines

Austria (1997)	+	+		+	12 or confirmatory test	1 or 2	Facultative	EEG Doppler + angiography
Belgium (1993)	+	+	6	+		3	Facultative	EEG (repeat 24 h) EP angiography
Denmark (1990, 1995)	+	+	6 anoxia: 24	+	2 mandatory	2	Facultative	Angiography
Finland (1971)	+	+		+		1	Facultative	EEG angiography
France (1968, 1996)	+	+		+		2	Mandatory	EEG (2×) angiography
Germany (1982, 1997)	+	+	Anoxia: 6	+	12 or confirmatory test	2	Facultative	EEG EP scintigraphy Doppler angiography
Italy (1993)	+	+	6 anoxia: 24	+	6	1 or more	Mandatory	EEG (3×)
Luxembourg (1983)	+	+				1	Mandatory	EEG, EP and angiography or scintigraphy
Netherlands (1997)	+	+		+		1 or more (Neurologist or Neurosurgeon)	Mandatory	EEG (Angiography if EEG or apnoea test impossible)
Poland (1996)	+	+		+	3	1	NO	
Switzerland (1983, 1996)	+	+	0.5 anoxia: 48	+	6 mandatory	2	Facultative	EEG EP scintigraphy angiography
United Kingdom (1993)	+	+	6 anoxia: 24	+	+ (discretionary)	2	NO	

Supratentoriell: 2. Klinische Untersuchung oder apparativ

Beobachtungszeitraum

- primäre Hirnschädigung: 12 Stunden
- sekundäre Hirnschädigung: 72 Stunden

Infratentoriell: Apparative Diagnostik obligat !

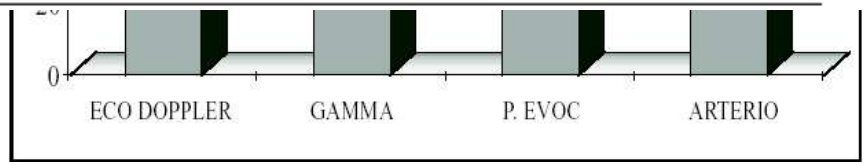
EEG, TCD, Hirnperfusionsszintigraphie, SEP, AEP

Originales

Recomendaciones sobre el uso del Doppler transcraneal para determinar la existencia de paro circulatorio cerebral como apoyo diagnóstico de la muerte encefálica

S. Calleja[1]
J. I. Tembl[2]
T. Segura[3]
en representación de la Sociedad Española de Neurosonología (SONES)

[1] Servicios de Neurología Hospital Universitario Central Asturias
[2] Hospital Universitari La Fe Valencia
[3] Hospital General Universitario Albacete



año 2000

M. T. NAYA, B. MIRANDA,
E. FERNÁNDEZ-ZINKE, J. CAÑÓN,
N. CUENDE

Organización Nacional de Trasplantes.

Neurología 2007;22(7):441-447

Recomendaciones del Doppler transcraneal en el diagnóstico de la muerte encefálica

J. Canal-Sotelo
N. Arraras-Torrelles

Servicios Sociosanitarios
Equipos de Atención Domiciliaria
Hospital Santa María
Lleida

Neurología 2008;23(6):395-398

En nuestra experiencia la realización de una exploración ultrasonográfica única, utilizando las ventanas temporales y suboccipital en el contexto de un enfermo en el que la exploración clinica es diagnóstica de muerte encefálica y siempre que en esta única exploración se detecten los patrones típicos descritos por los autores[1], es suficiente para la realización del diagnóstico.

El Real Decreto 1070/1999, de 30 de diciembre, que regula las actividades de obtención y utilización clinica de órganos humanos recoge la posibilidad de utilizar exploraciones complementarias como medio para acortar el período de observación[4], algo cada vez más necesario cuando el diagnóstico de muerte encefálica va unido a un programa de donación de órganos, por lo que, a nuestro parecer, retrasar 30 min más este diagnóstico podría alterar aún más las precarias condiciones homeostáticas de los posibles donantes y reducir las posibilidades de extracción de órganos[5].

Critères paracliniques

- Légaux : - EEG
  - angiographie
- Admis : - angioTDM
- Non admis : - doppler TC
  - potentiels évoqués

Décret n°96-1041 du 2 décembre 1996 (JO)

“**La vélocimètrie Doppler transcrânienne n’a pas de valeur réglementaire pour le diagnostic de la ME.**

Cependant, non invasive et facilement réalisée et répétée au lit du malade, elle

est prédictive de ME avec une spécificité de 100% et une sensibilité de l’ordre de 90 % en visualisant l’arrêt circulatoire cérébral.”

Décret n°96-1041 du 2 décembre 1996 (JO)

4.2 Reversible Causes of Coma

Potentially reversible causes of coma must be excluded and include:

1) ***Sedative drugs***: Narcotics, hypnotics and tranquillisers may have prolonged action, particularly when hypothermia coexists or in the context of renal or hepatic failure. It is therefore essential that the drug history should be carefully reviewed. Any possibility of intoxication being the cause of, or contributing to, the patient's comatose state should preclude certification of death by brain stem testing.

   Excluding the effects of sedatives may be difficult, particularly after prolonged infusions of long acting cumulative sedatives such as thiopentone. This may involve prediction according to pharmacokinetic principles, the measurement of drug concentrations which may be time consuming or the use of antagonists in the case of opioids or benzodiazepines. If the patient is thought to be brain stem dead, the decision is either to wait to perform the tests when the effect of such sedatives can be excluded, or to withdraw further active treatment on the basis of futility. If sedation cannot be excluded it may be appropriate to consider the use of imaging techniques such as four vessel cerebral angiography or transcranial Doppler to demonstrate the absence of cerebral blood flow, so assisting decision making by confirming futility, even though these do not currently form part of the diagnostic requirements for the diagnosis of brain stem death.

CONFIRMING TEST OF CIRCULATORY ARREST IN ITALY

National Council for Transplantation Italian guidelines (2003) update April 11th 2008*

Decreto Ministeriale 22 agosto, 1994, n° 582

1. Children younger than one year old

2. The presence of concomitant factors (drug depressors of CNS, hypothermia, metabolic alterations, systemic hypotension) that can interfere on the clinical evaluation

3. Situations that do not allow Cerebral Angiography, Brain Scintigraphy and Transcranial Doppler are accepted and recommended …"

On The use of Confirmatory Tests for cerebral circulatory arrest in particular situations for the diagnosis of brain death in patients with cerebral lesions.
(Decreto Ministeriale 22 agosto, 1994, n° 582)

… among the methodologies now in use for the assessment of cerebral blood flow arrest Cerebral Angiography, Brain Scintigraphy and Transcranial Doppler are accepted and recommended …"

diagnosis or the evaluation of brain-stem reflexes or the EEG recording

CENTRO NAZIONALE TRAPIANTI

*(no changes compared to previous guiselines about the diagnosis of the absence of cerebral blood flow)

TRANSCRANIAL DOPPLER PROCEDURE FOR THE DIAGNOSIS OF CEREBRAL BLOOD FLOW ARREST

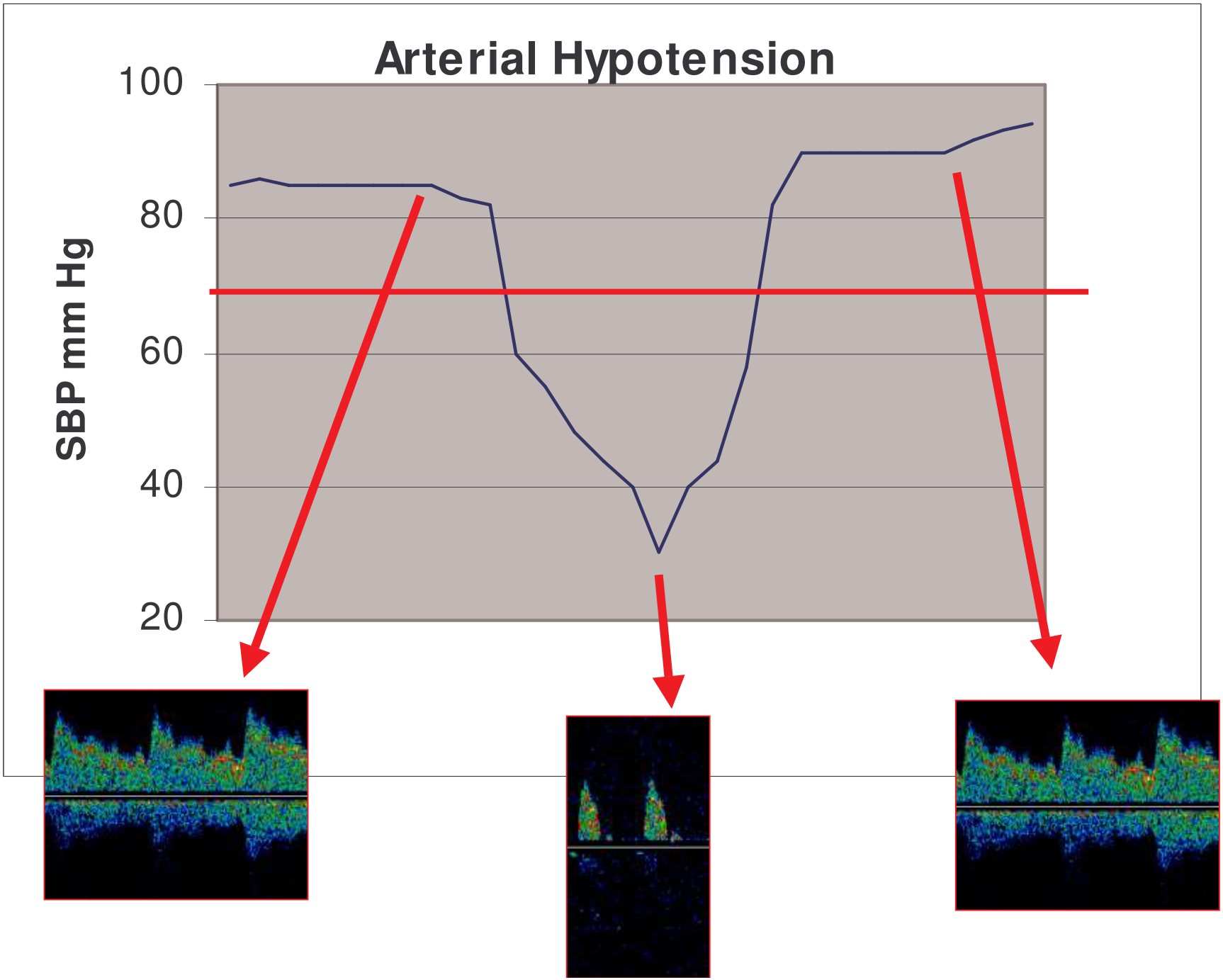
- **SOVRATENTORIAL BILATERAL EXAMINATION (through the temporal acoustic windows)**

- **INFRATENTORIAL EXAMINATION (through the occipital acoustic window)**

CENTRO NAZIONALE TRAPIANTI

- IN ORDER TO EXCLUDE CEREBRAL BLOOD FLOW TRANSIENT ARREST DUE TO HYPOTENSION, DURING THE TCD EXAMINATION, SYSTEMIC ARTERIAL BLOOD PRESSURE VALUES MUST ALWAYS BE CHECKED

(SYSTOLIC VALUES HAVE TO BE > 70mmHg)

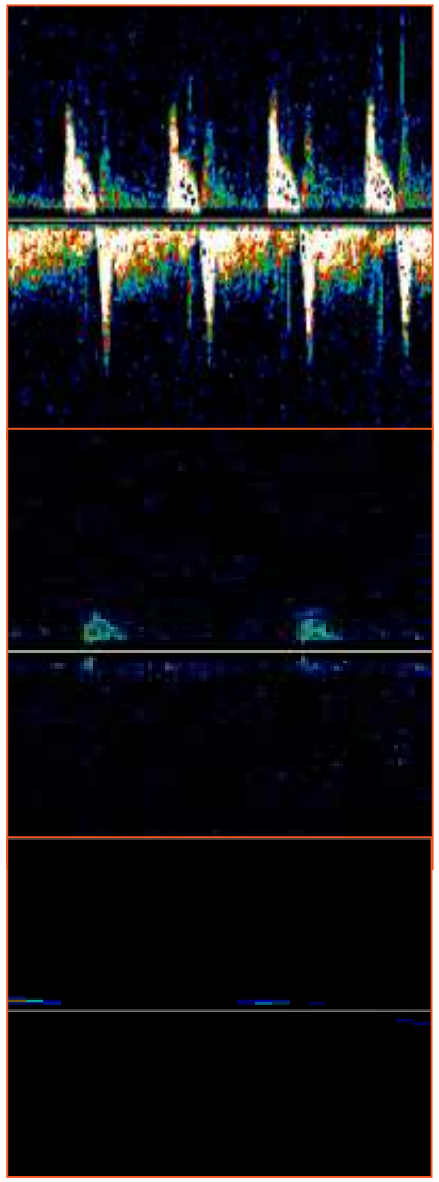

Arterial Hypotension
SBP mm Hg
100
80
60
40
20

Diagnostic TCD Patterns of cerebral circulatory arrest

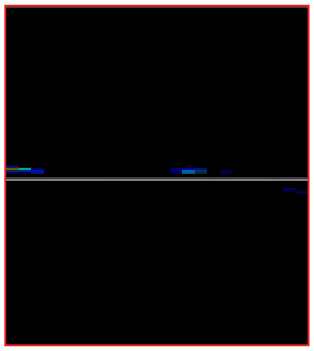
1)Reverberating Flow

2) Systolic Spikes

3) No signal



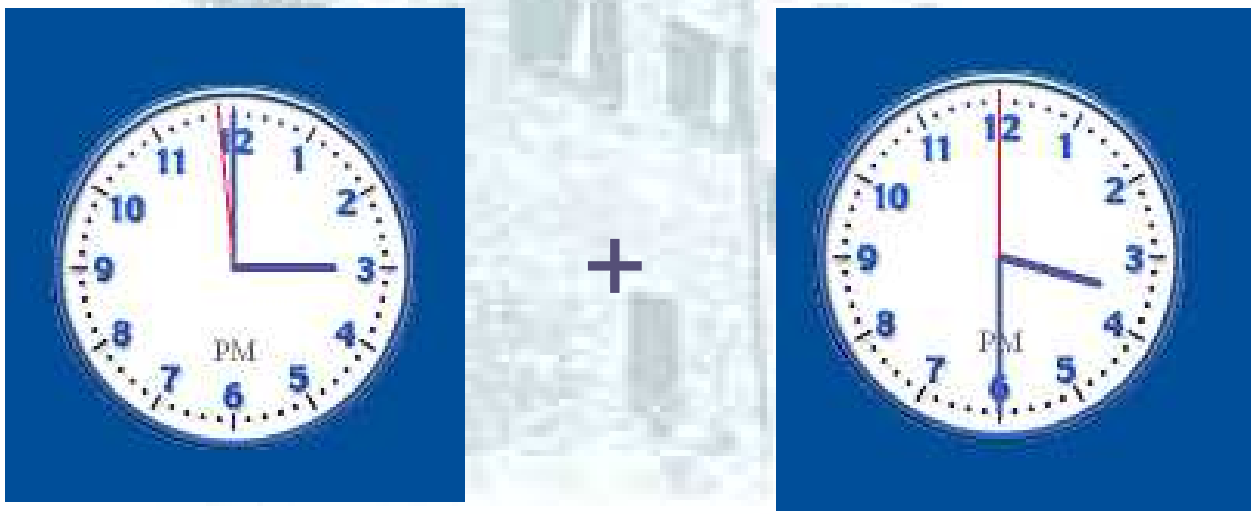
3) **No signal pattern is accepted only in the two following cases:**



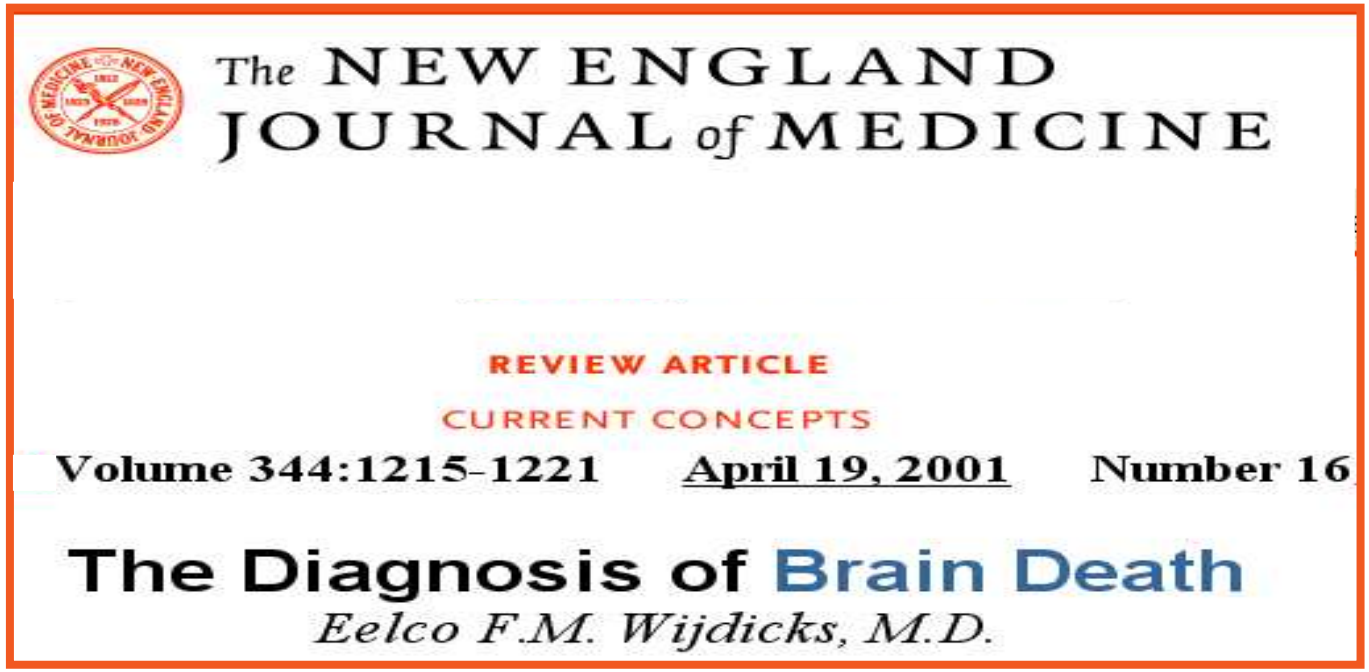
I. When through each of the three acoustic windows the signal in at least one vessel is detectable, with one of the patterns described at point 1 or 2

II. When, during a previous examination, performed by the same physician in the same patient, TCD signal was detected in basal arteries

TCD PATTERNS OF BRAIN DEATH MUST BE DETECTED IN AT LEAST TWO EXAMINATIONS PERFORMED IN NOT LESS THAN THIRTY MINUTES ONE FROM THE OTHER



CENTRO NAZIONALE TRAPIANTI



"Brain death is the principal requisite for the donation of organs for transplantation"

CONCLUSIONS

Time delay in the diagnosis of BD is one of the main causes for the relatively small number of organ donors

TCD is superior to conventional confirmatory tests in reducing the waiting time for a firm diagnosis of brain death

TCD examination allows an useful cut of waiting time for organ donation

In particular clinical conditions it can be considered the first choise- confirmatory test of BD