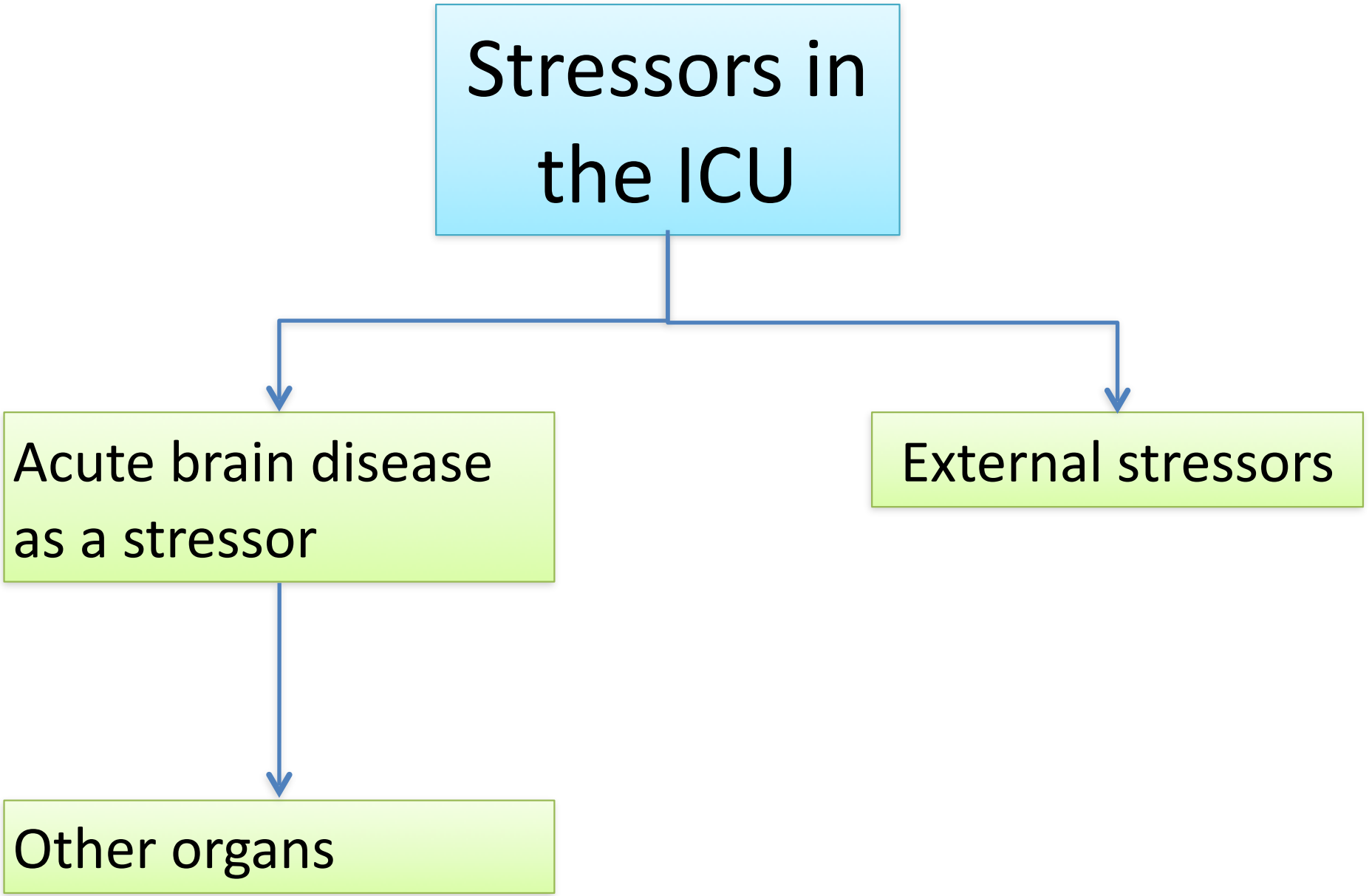
SIADH ?

Basal serum cortisol concentration was low at 110 nmol/l with undetectable plasma ACTH levels.

The patient had a rapid response to the administration of IV hydrocortisone with normalization of plasma sodium, plasma glucose and blood pressure.

The combination of hyponatraemia, hypoglycaemia and hypotension suggested the diagnosis of ***acute hypopituitarism with secondary adrenal failure.***

Agha A, Sherlock M, C.J. Thompson CJ. QJM 2005; 98: 463-464

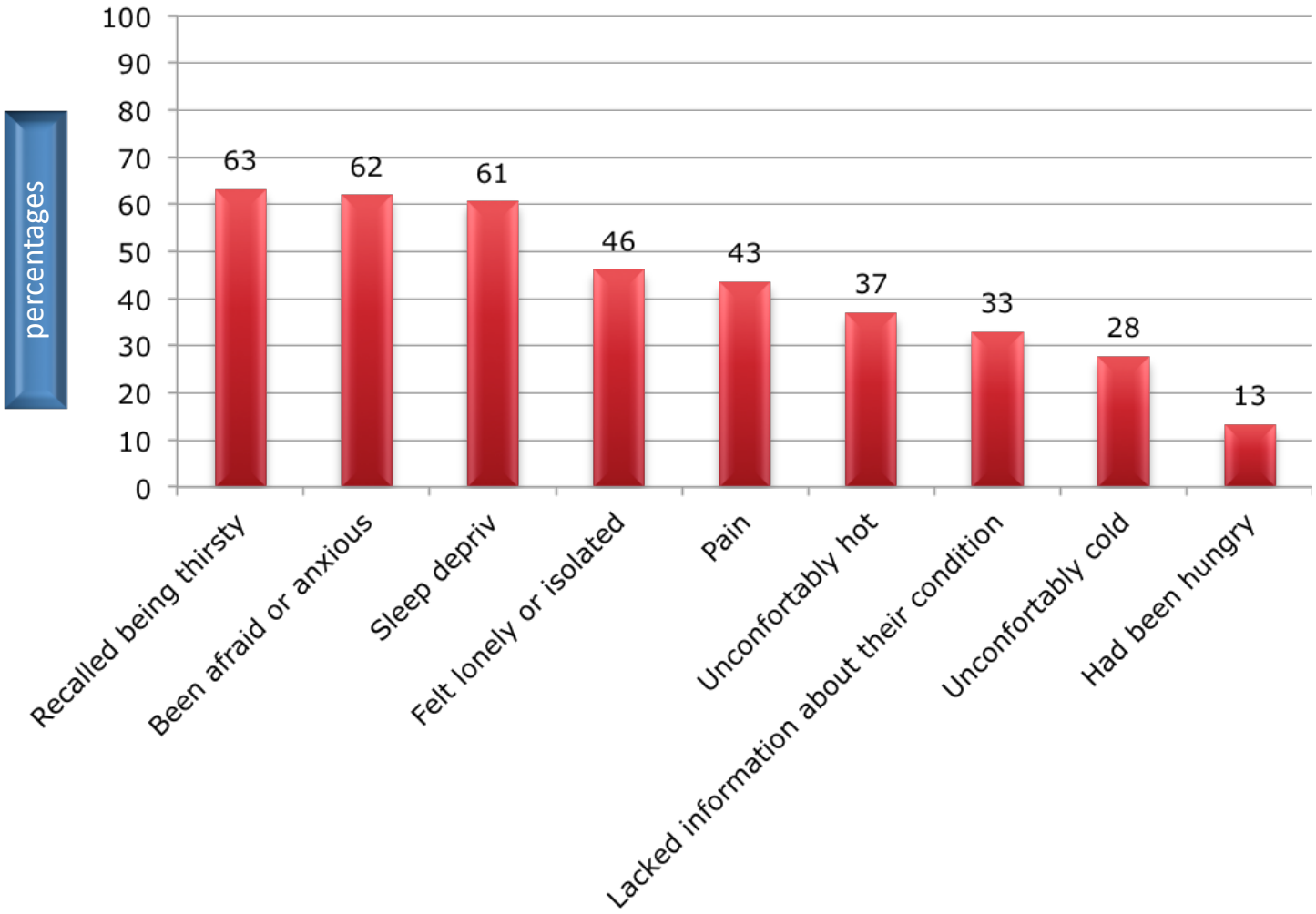

Stressors in the ICU
Acute brain disease as a stressor
External stressors
Other organs

Patients' perceptions of intensive care

Bruno Simini

Lancet 1999; 354:571-572

Within 3 days of discharge from the intensive-care unit,76 patients were interviewed by an intensive-care specialist who had not seen them before



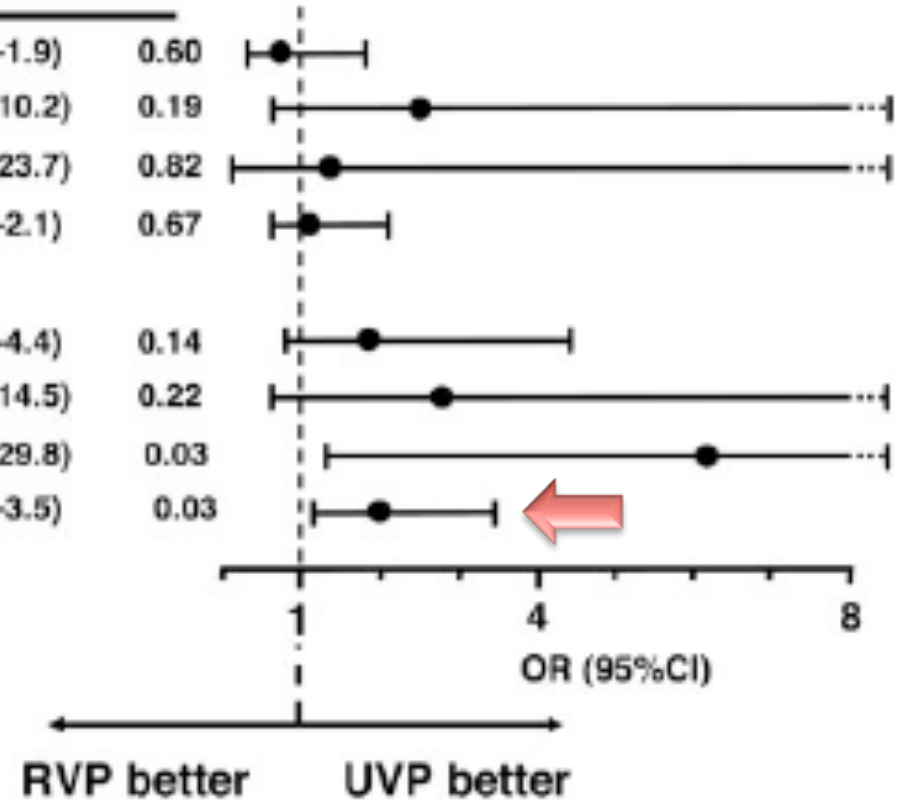
Reduced Cardiocirculatory Complications With Unrestrictive Visiting Policy in an Intensive Care Unit

Results From a Pilot, Randomized Trial

Stefano Fumagalli, MD; Lorenzo Boncinelli, MD; Antonella Lo Nostro, BSc; Paolo Valoti, MD; Giorgio Baldereschi, MD; Mauro Di Bari, MD, PhD; Andrea Ungar, MD; Samuele Baldasseroni, MD; Pierangelo Geppetti, MD; Giulio Masotti, MD; Riccardo Pini, MD; Niccolò Marchionni, MD

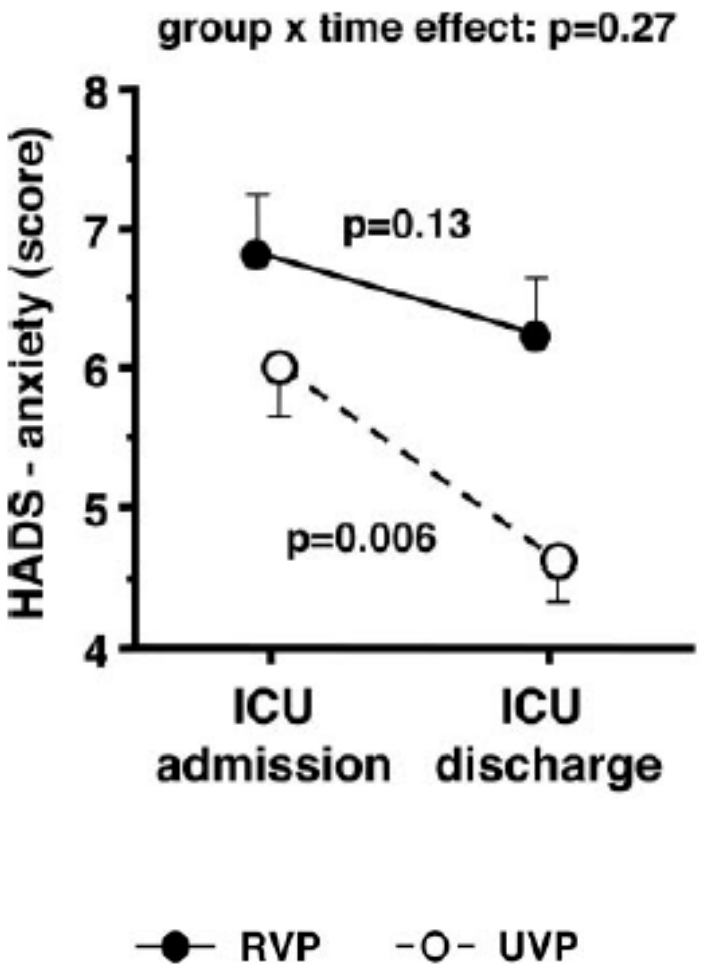
Circulation **2006**; 113:946-952

	RVP (n=115)	UVP (n=111)	OR (95%CI)	p
Pneumonia, %	8.7	12.6	0.7 (0.3-1.9)	0.60
UT infection, %	7.0	2.7	2.5 (0.6-10.2)	0.19
Generalized sepsis, %	0.9	0.9	1.4 (0.1-23.7)	0.82
Any infection, %	16.6	14.2	1.1 (0.6-2.1)	0.67
Arrhythmias, %	14.8	9.0	1.9 (0.8-4.4)	0.14
Cardiac rupture, %	5.2	1.8	2.8 (0.6-14.5)	0.22
Pul. edema/shock, %	8.7	1.8	6.1 (1.3-29.8)	0.03
Any CV compl., %	28.8	12.6	2.0 (1.1-3.5)	0.03

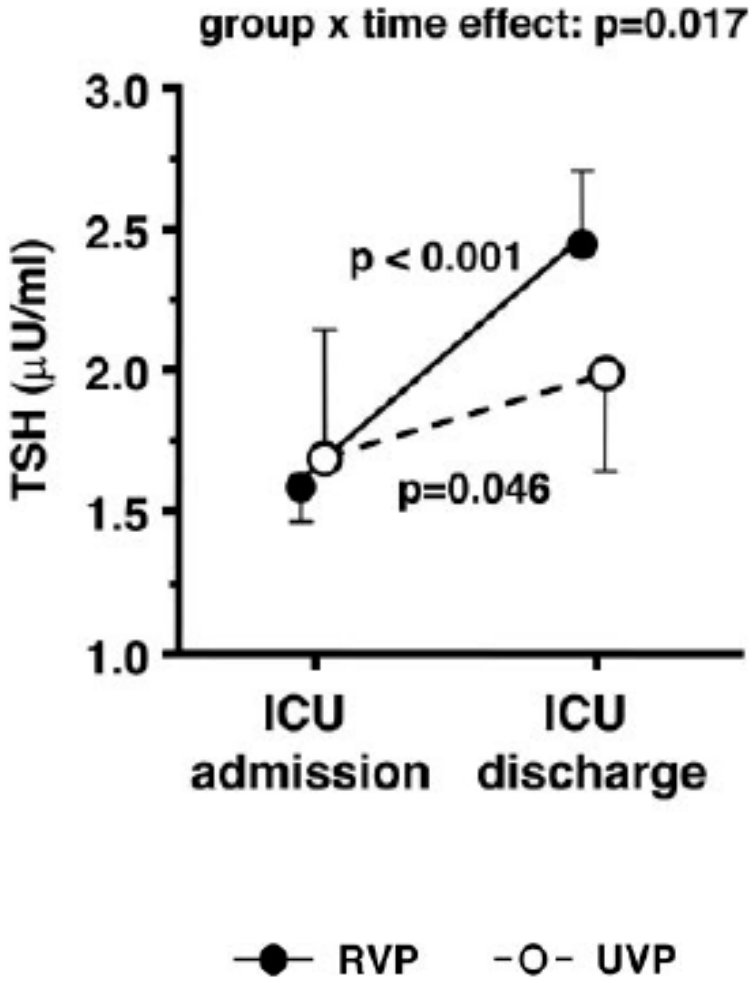


RESULTS

Anxiety



Stress hormones

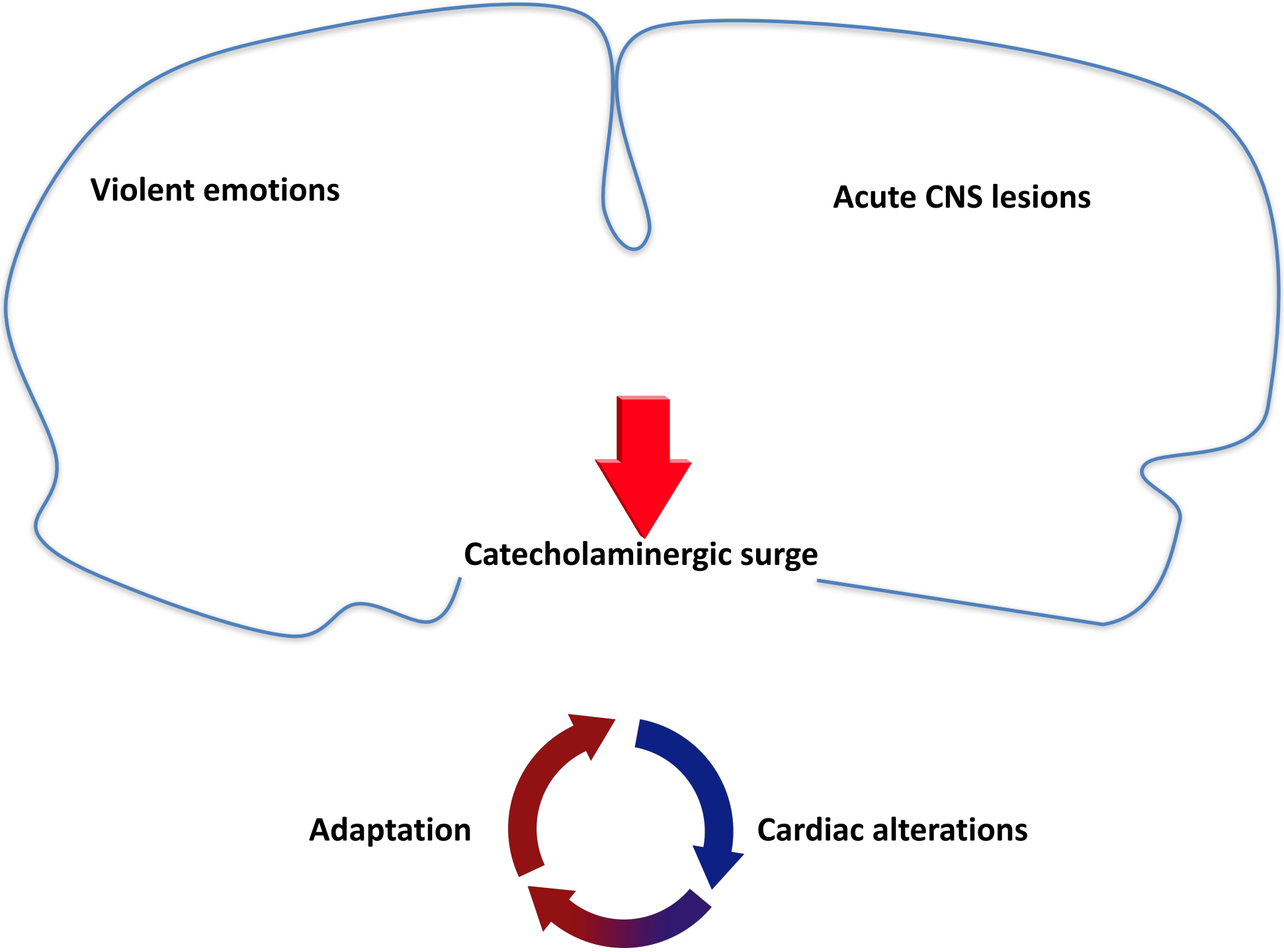


Fumagalli S, et al. *Circulation* **2006;** 113:946-952

CONCLUSIONS

Liberalizing visiting hours in ICUs does not increase septic complications, whereas it might reduce cardiovascular complications, possibly through reduced anxiety and more favorable hormonal profile.

Fumagalli S, et al. *Circulation* **2006;** 113:946-952

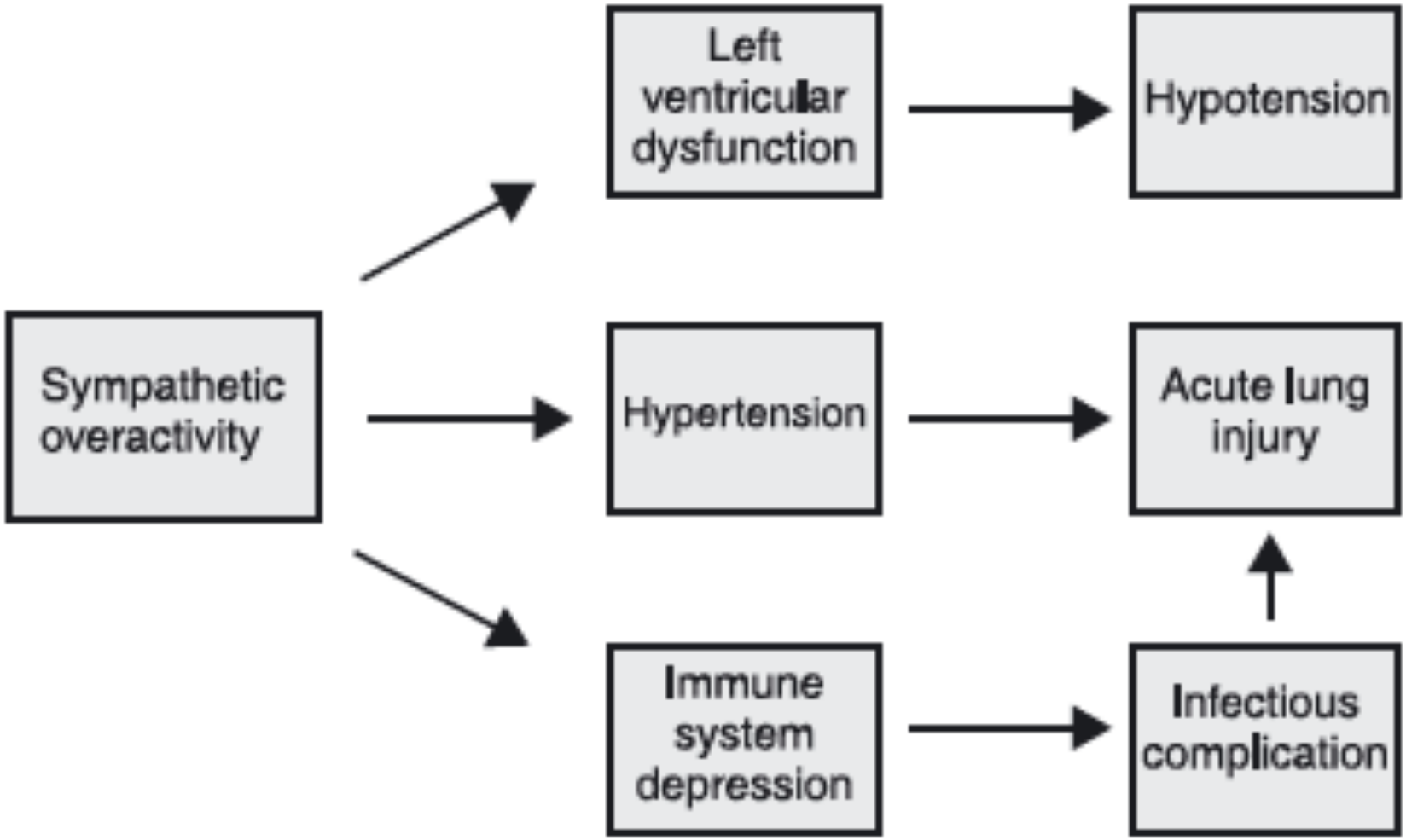

Violent emotions
Acute CNS lesions
Catecholaminergic surge
Adaptation
Cardiac alterations

REVIEW ARTICLE

Systemic complications after head injury: a clinical review

H. B. Lim[1] and M. Smith[2]

Anaesthesia 2007; 62: 474-82



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Systemic complications after head injury: a clinical review

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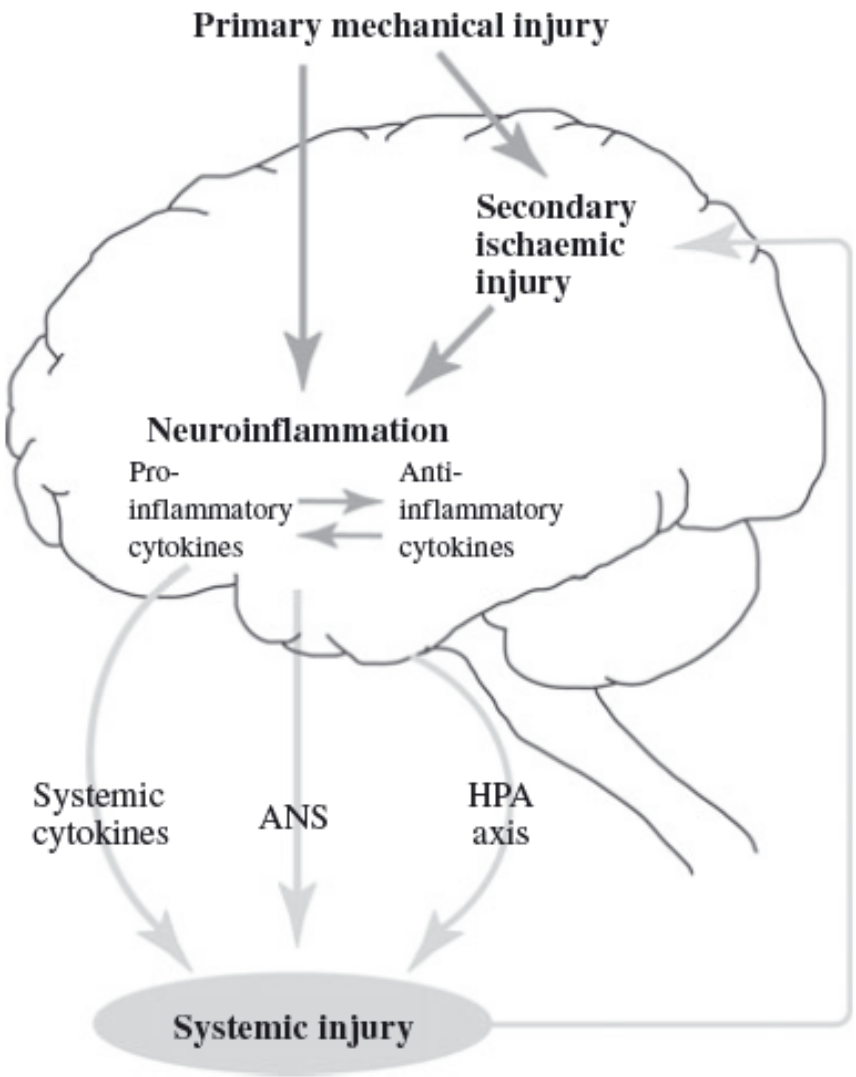


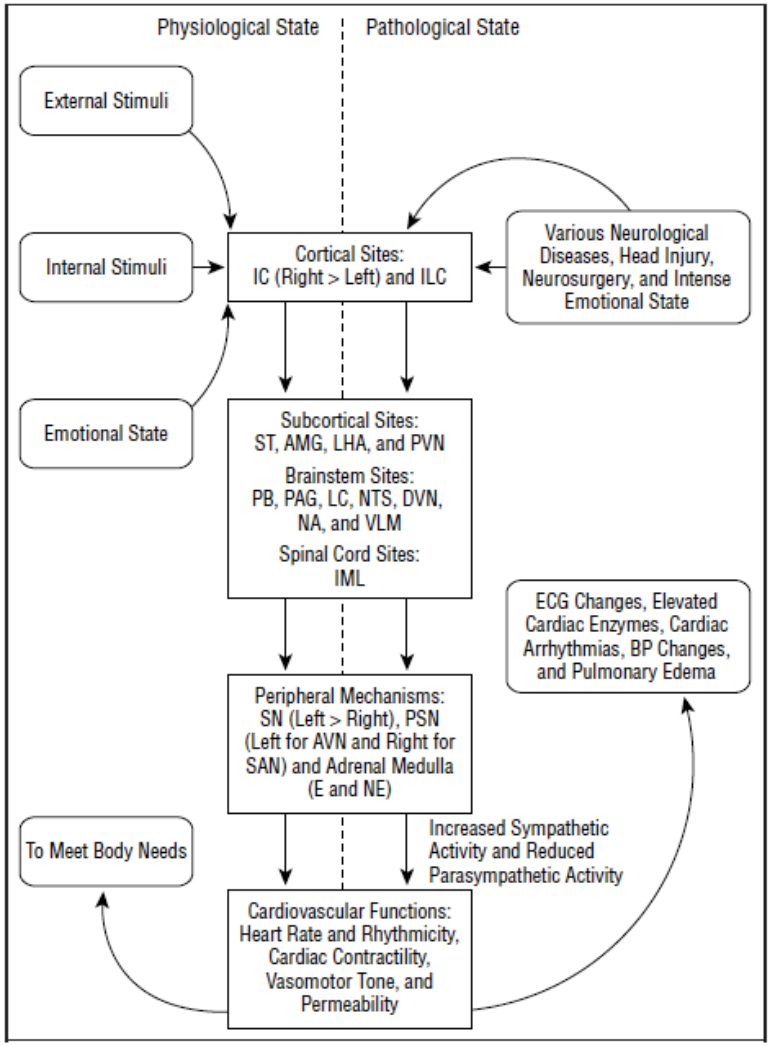
Primary mechanical injury and secondary ischaemic/reperfusion injury induces a neuro-inflammatory reaction. Neuro-inflammation causes systemic organ injury via three interrelated mechanisms: overspill of intracranial cytokines into the systemic circulation; the autonomic nervous system (ANS); the hypothalamic-pituitary-adrenal axis (HPA).

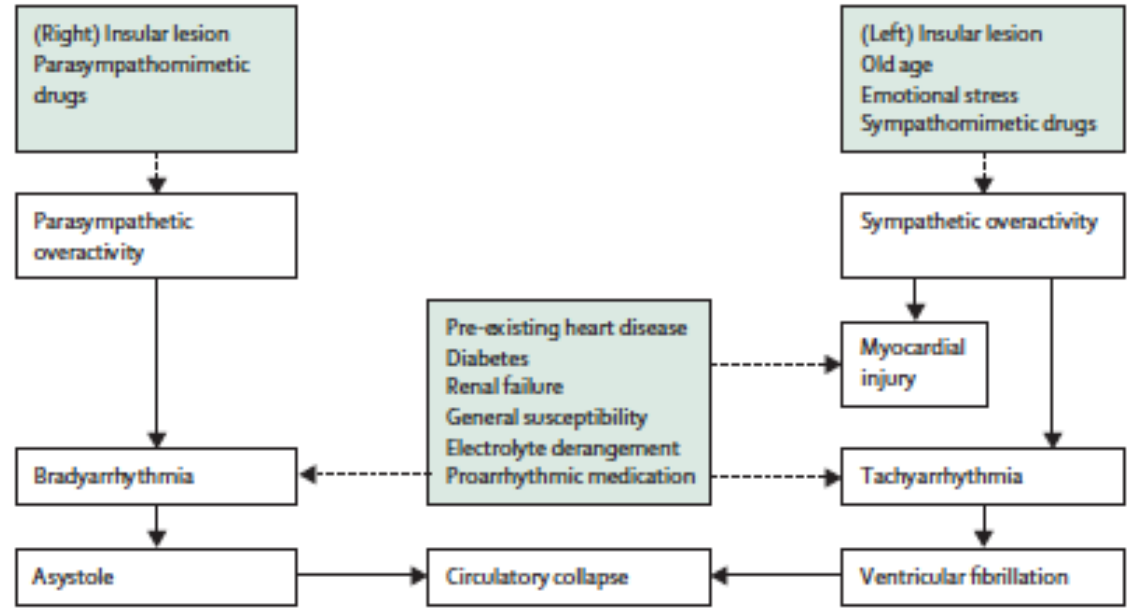
SECTION EDITOR: DAVID E. PLEASURE, MD

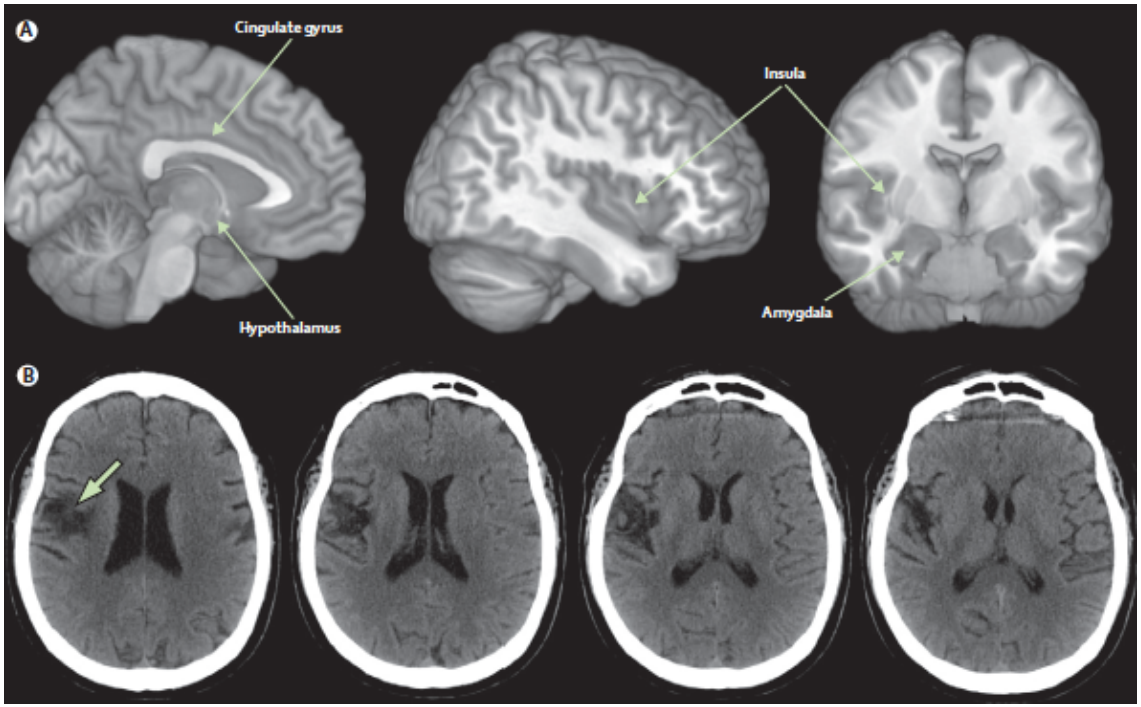
The Insula and Cerebrogenic Sudden Death

Raymond T. F. Cheung, MBBS, PhD; Vladimir Hachinski, MD, DSc

Arch Neurol 2000; 57:1685–1688







Lancet Neurol 2012; 11: 179–88

Case report

A previously healthy, six-year-old girl reported a tingling sensation in her fingers and six hours later began to stagger and fall. The next day, she was unable to walk without assistance. She was brought to the Medical College of Georgia 30 hours after the onset of symptoms.

On initial examination, the child, who had long hair, was alert and afebrile, but had truncal instability and a wide-based, ataxic gait. She was unable to walk without support. Muscle strength was 4/5 in the legs and arms, proximally and distally. Dysmetria of the arms was noted on finger-to-nose testing. Muscle-stretch reflexes were diminished at the left knee but were normal elsewhere. The findings on tests of sensory-nerve and cranial nerve function were normal, as was the rectal-sphincter tone.

New Engl J Med **2000**; 342:90-94

Case report

Chest radiographs and routine laboratory studies showed no abnormalities. Tests for toxic substances and a stool culture were negative.

The initial differential diagnosis included acute cerebellar ataxia, cervical-cord compression, and the Guillain-Barré syndrome.

MRI studies of the head and neck showed no abnormalities. Analysis of a cerebrospinal fluid specimen was unhelpful.

New Engl J Med **2000**; 342:90-94

48 hours after the onset of symptoms, the child became lethargic and irritable. Symmetric leg weakness increased, with muscle strength of 3/5. The child could barely sit, even with support. Forced vital capacity was 20 ml per kilogram (normal value for age >40).

ICU admission?

The end-tidal partial pressure of carbon dioxide was 53 mm Hg. Oxygen saturation was maintained at 98 percent with nasal administration of oxygen.

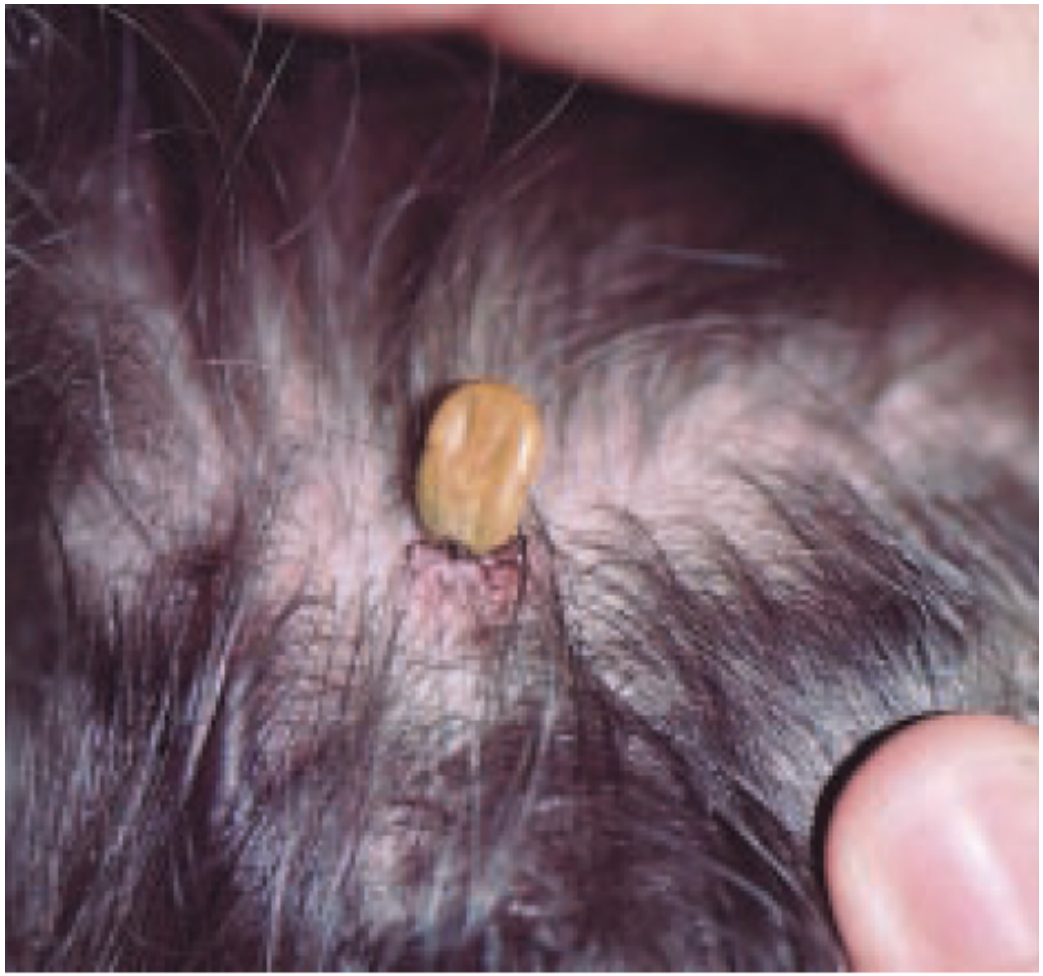
ICU admission?

Because of the ascending paralysis and hypoventilation, the child was transferred to the pediatric ICU for monitoring and possible intubation. The clinical impression was that the child had Guillain-Barré syndrome.

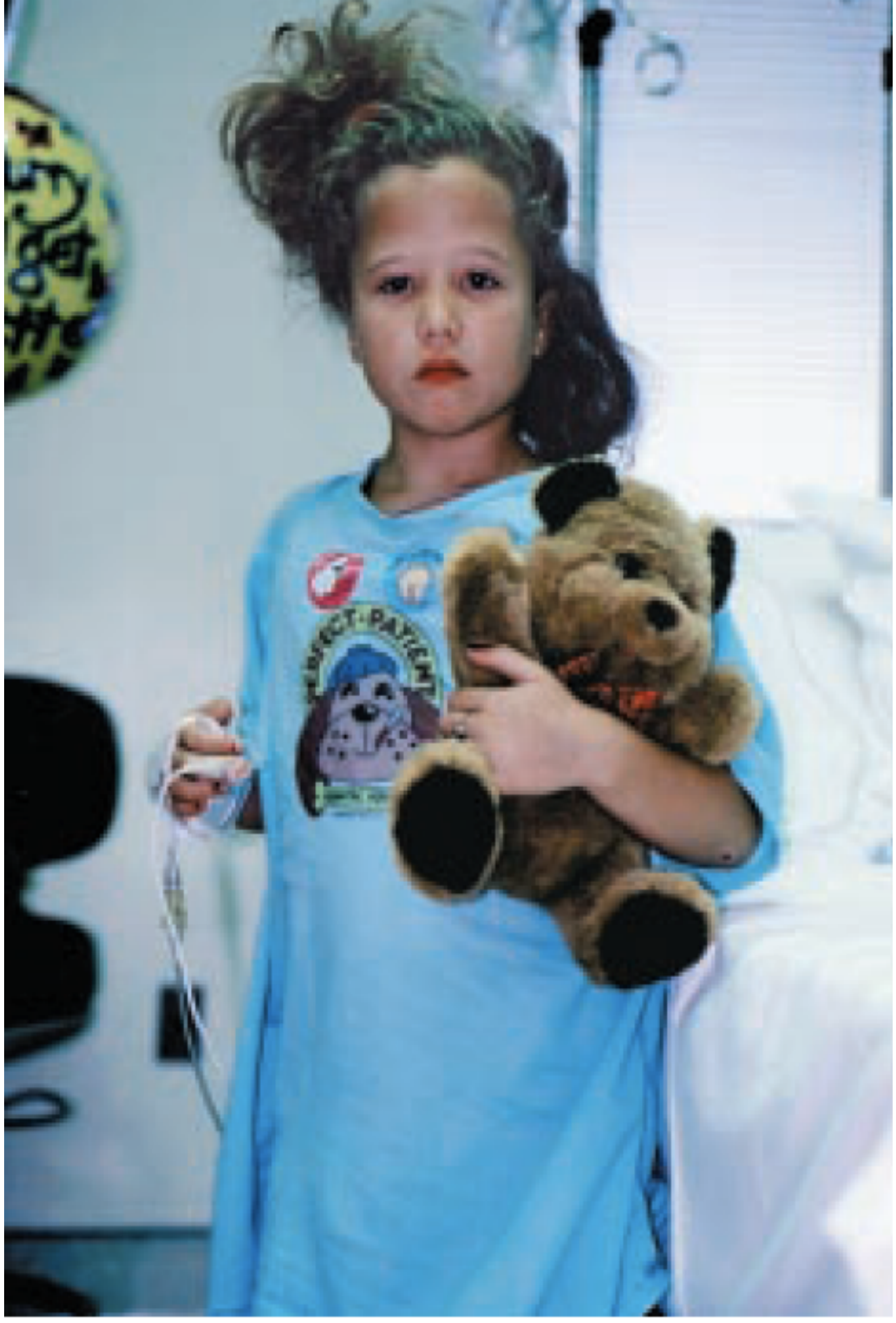
By 72 hours after the onset of illness, motor strength in the arms and legs had decreased to 2/5. Listlessness, slurred speech, and bilateral ptosis were observed. Because of the rapid deterioration in association with a presumed diagnosis of Guillain-Barré syndrome, preparation for femoral-vein access was initiated for emergency plasmapheresis.

New Engl J Med 2000; 342:90-94

During placement of the central catheter, ***an astute pediatric resident*** carefully inspected the child's hair with a fine-toothed comb. To the surprise of the three pediatricians, the pediatric neurologist, and the pediatric intensivist who were caring for the child, an engorged tick, 15 mm in diameter, was embedded in the left parietal area of the scalp.

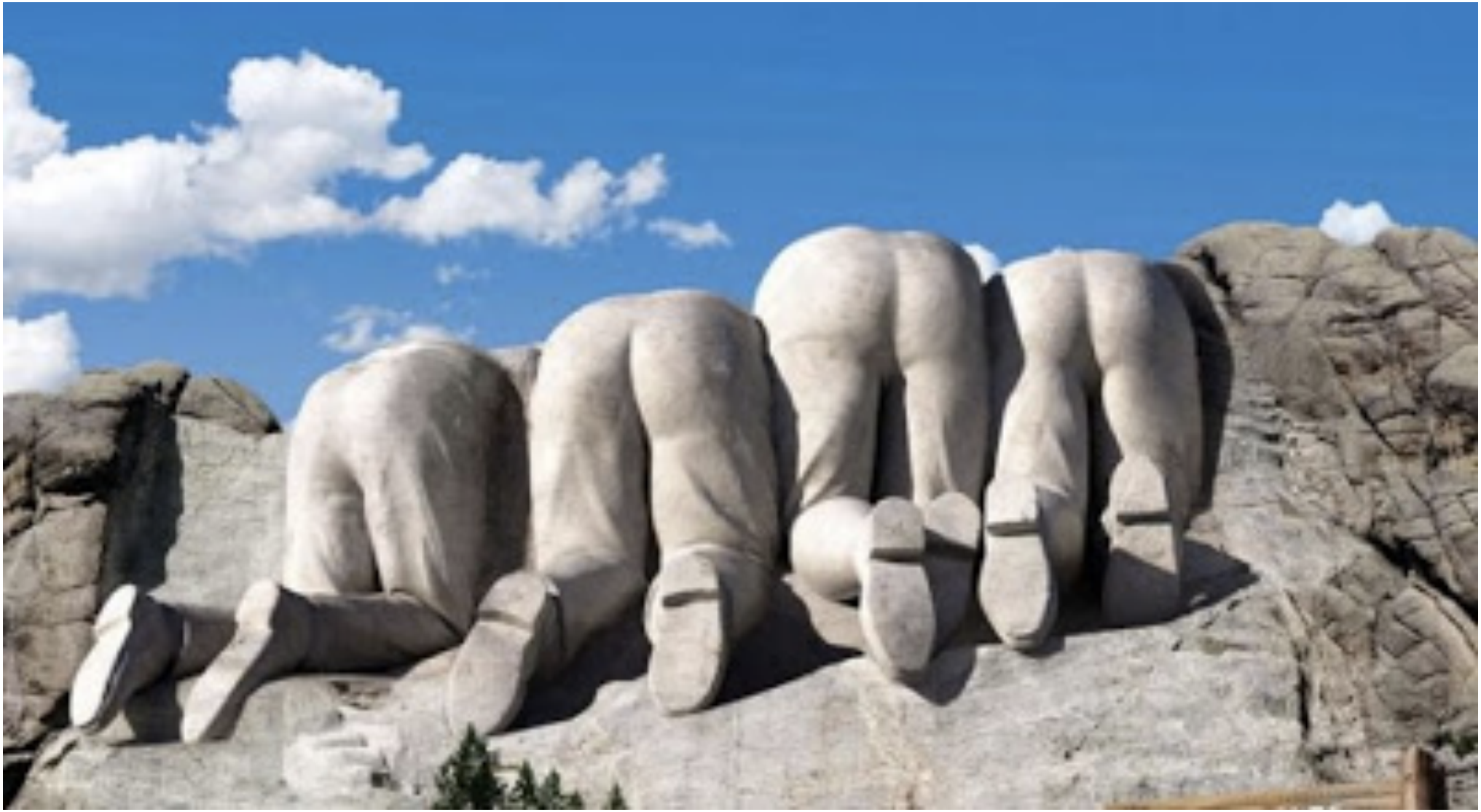


Within 6 hours after removal of the tick, the child's slurred speech, ptosis, and lethargy had resolved. **Within 8 hours**, her strength had improved to 4/5 in the arms, and she could elevate her arms above her head. In addition, the forced vital capacity increased to 50 ml per kilogram, and the oxygen saturation increased to 99 percent while the child was breathing room air. **Within 12 hours**, she could sit up with minimal assistance and elevate her legs against moderate resistance. Areflexia persisted **until 17 hours** after removal of the tick, when muscle-stretch reflexes at the ankles and knees returned to normal. **Within 24 hours**, ataxia of the trunk, arms, and legs had fully resolved, and the child could walk without assistance.



Localisation	Pre-existing	Previously Undiagnosed/New Onset	ICU Complication
Brain cortex and brainstem	Encephalitis Epilepsy Multiple sclerosis Vascular causes (brainstem infarction or haemorrhage; cerebral haemorrhage; ischaemic stroke)	Acute disseminated encephalomyelitis Encephalitis (including paralytic form of rabies) Multiple sclerosis Post-cardiac arrest encephalopathy Status epilepticus Tetanus Vascular causes	Post-cardiac arrest encephalopathy Status epilepticus (including nonepileptic) Vascular causes
Spinal cord (including anterior horn cells)	Amyotrophic lateral sclerosis Ischaemia Malformations (Arnold-Chiari) Poliomyelitis Post-polio syndrome Spinal muscular atrophy Trauma	Compression (tumour, infection, haematoma) Herpes zoster Ischaemia Transverse myelitis Surgery Tetanus Trauma West Nile virus poliomyelitis	Hopkins syndrome
Peripheral nerve	Alcohol abuse Chronic inflammatory demyelinating polyneuropathy Drugs* (bortezomib, cisplatin, dichloroacetate, epothilone, isoniazid, ixabepilone, leflunomide, linezolid, nitrofurantoin, oxaliplatin, pyridoxine, reverse transcriptase inhibitors, statins, taxanes, thalidomide, tumour necrosis factor-alpha blockers, vincristine) Guillain-Barré syndrome Hormonal disorders (acromegaly, hypothyroidism) Infections (diphtheria, HIV, Lyme disease) Tumours (carcinoma, lymphoma, multiple myeloma) Metabolic (diabetes, porphyria, tyrosinaemia, uraemia) Nutritional (thiamine deficiency) Sarcoidosis Toxic (acrylamide; heavy metals: arsenic, thallium, lead, gold; organophosphates; hexacarbons) Vasculitis (polyarteritis nodosa, lupus erythematous, rheumatoid arthritis, Churg-Strauss)	Acute intermittent porphyria Entrapment neuropathy Guillain-Barré syndrome HIV Tetanus Tick paralysis Toxic Vasculitis	Entrapment neuropathy Critical illness polyneuropathy
Neuromuscular junction	Botulism. Lambert-Eaton syndrome. Myasthenia gravis Drugs*. Anesthetic agents (desflurane, enflurane, halothane, isoflurane, nitrous oxide, opioids, propofol, sevoflurane). Antibiotics: *amynoglycosides*$^{+}$ (amikacin, clindamycin, gentamycin, kanamycin, lincomycin, neomycin, streptomycin, tobramycin); *fluoroquinolones* (ciprofloxacin, gemifloxacin, levofloxacin, lomefloxacin, moxifloxacin, norfloxacin, ofloxacin, and trovafloxacin); *macrolides* (azithromycin, erythromycin, telithromycin), *other antibiotics* (ampicillin, bacitarcin, polymyxins, tetracyclin, imipenem/cilastatin, penicillin, vancomycin). anti-arrhythmic agents (etafenone, peruvoside, procainamide, propafenone). antiepileptics (carbamazepine, gabapentin, phenytoin, trimethadione). beta-blockers** (atenolol, nadolol, oxprenolol, practolol, propranolol, sotalol, ophthalmic timolol). calcium-channel blockers** (amlodipine, felodipine, nifedipine, verapamil). corticosteroids***. Chemotherapics (doxorubicin, etoposide, cisplatin). H-2 receptor antagonists (cimetidine, ranitidine, roxatidine). quinolone derivatives (chloroquine, quinidine, quinine). Noncompetitive neuromuscular blocking agents^{+}. Psychotropic medications (amitriptyline, chlorpromazine, haloperidol, imipramine, lithium). Other drugs (interferon, penicillamine).	Hypermagnesaemia Myasthenia gravis Snake, scorpion and spider bites fish, shellfish, jellyfish and crab toxins Tetanus	Hypermagnesaemia Prolonged neuromuscular blockade
Muscle	Metabolic/congenital Mitochondrial myopathies Muscular dystrophies Periodic paralyses (muscle channelopathiyes) Polymyositis	Adult-onset acid maltase deficiency Hypo- and hyperkalaemia Hypophosphataemia Muscular dystrophies Polymyositis Pyomyositis Rhabdomyolysis Tetanus Toxic myopathies	Corticosteroid myopathy Critical illness myopathy Hypo- and hyperkalaemia Hypophosphataemia Propofol infusion syndrome Disuse atrophy Rhabdomyolysis

Latronico N, Fagoni N. ***Neuromuscular disorders and ICU acquired neuromuscular weakness***. In: Oxford Textbook of Neurointensive Critical Care. Smith M, Kofke AW, Citerio G (Eds). Oxford University Press, Oxford, England, 2014.



WHAT IS NEUROCRITICAL CARE MEDICINE

Primary neurological diseases

Any life-threatening ***diseases*** affecting:

Brain
Spinal cord
Peripheral nerve
NM transmission
Muscle

Systemic complications of neurologic diseases

SAH & Tako-tsubo
Coma & Pneumonia
Diabetes insipidus & Hypovolemia
SUDEP & Cardiac arrest
Spinal cord injury & Ventilator dependency
GBS & Neuromuscular respiratory failure

Neurologic complications of systemic diseases

Acute respiratory failure/brain hypoxia
Cardiac arrest/Hypoxic ischemic brain damage
DVT, embolization/brain infarction
Electrolyte imbalance/osmotic-demyelinating brain damage
Hypo- hyperthermia/metabolic brain changes
Immobility, sedation/delirium, disuse muscle atrophy
Shock, systemic hypotension/brain infarction
Systemic infections/meningitis
Sepsis/sepsis-associated CNS (delirium) & PNS (ICUAW) damage

The brain changes its physical shape

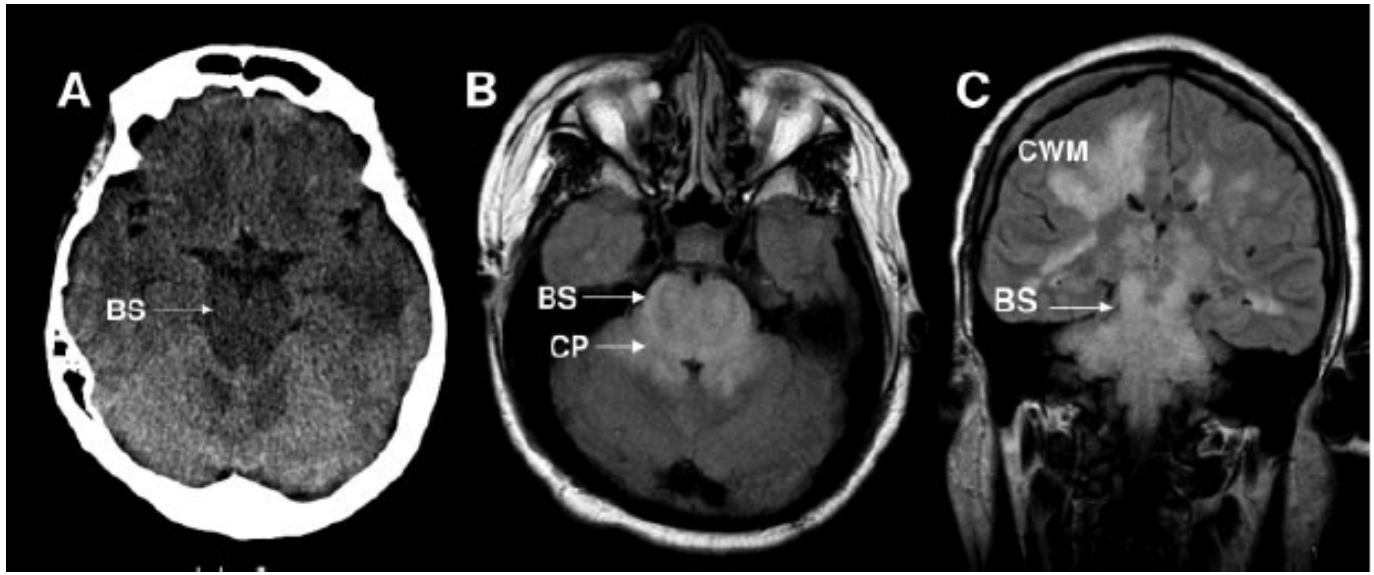
Hypertensive Brainstem Encephalopathy

Raymond C.S. Seet; Erle C.H. Lim

Circulation 2007; 115:e310-e311

A 2-day history of bitemporal headaches and a sudden onset of left-sided weakness 4 days after ingesting traditional Chinese medications for non-specific abdominal pain.

Drowsy, disoriented,and dysarthric, with a blood pressure of 270/170 mmHg. Blood tests suggested rhabdomyolysis.



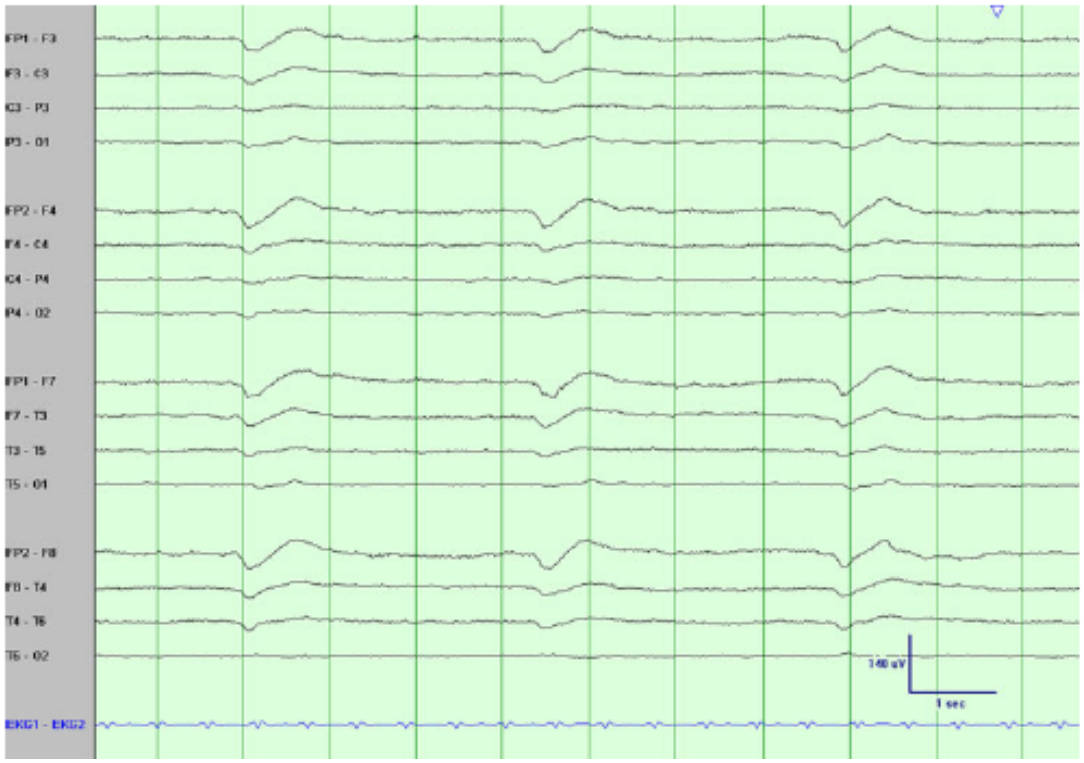
The patient's neurological deficits and MRI changes normalized with achievement of normal blood pressure.

The brain changes its function

Flat EEG, brain edema and coma

A 35-year-old male with a history of previous heavy alcohol abuse and hyperacute hepatic encephalopathy.

Over the next several days he made steady recovery and was extubated and transferred to the hepatology service by day 9, fully ambulatory and conversant, with only disorientation to date.

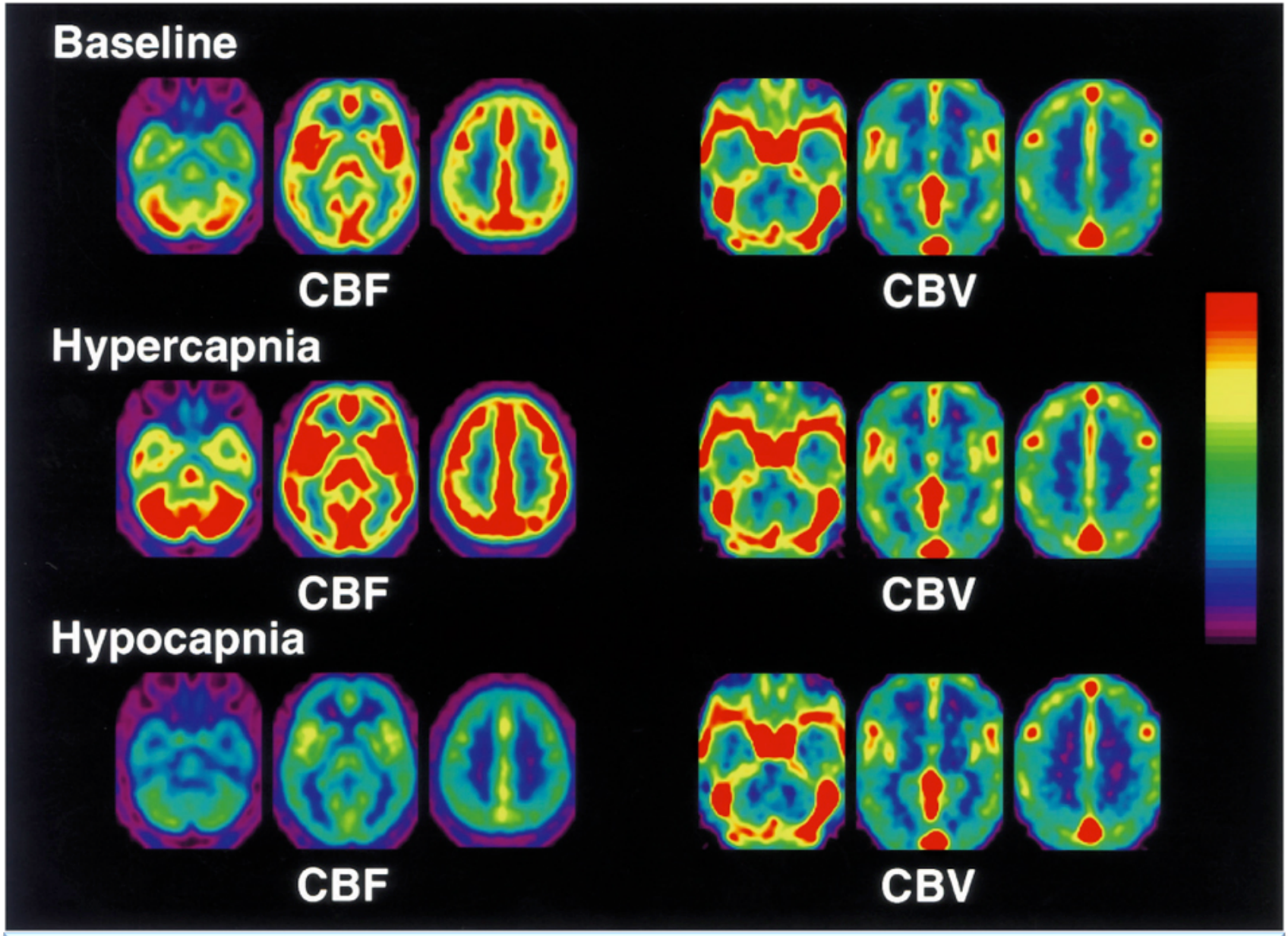


The EEG shows generalized suppression. The periodic complexes occuring every 3.5 s are respiration-related artifact.

Neurocrit Care **2010**; 13:247–251

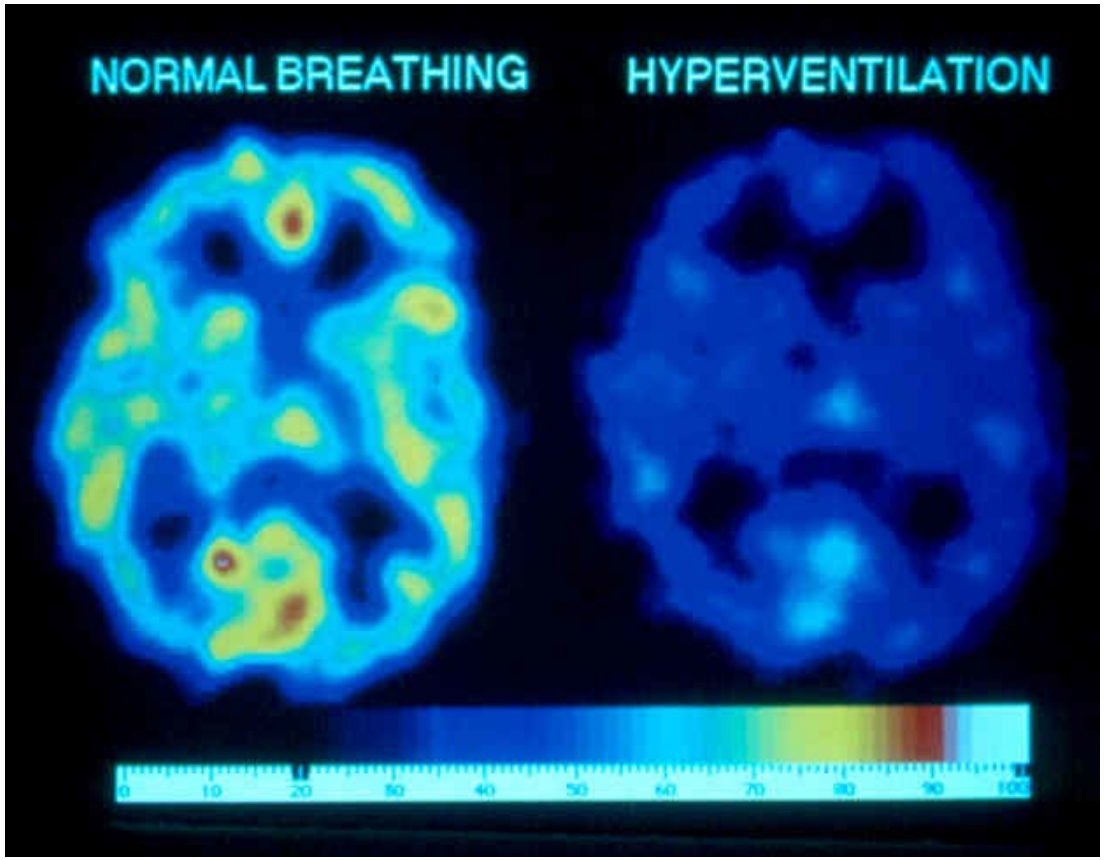
The brain changes its shape and function

HYPOVENTILATION AND HYPERVENTILATION



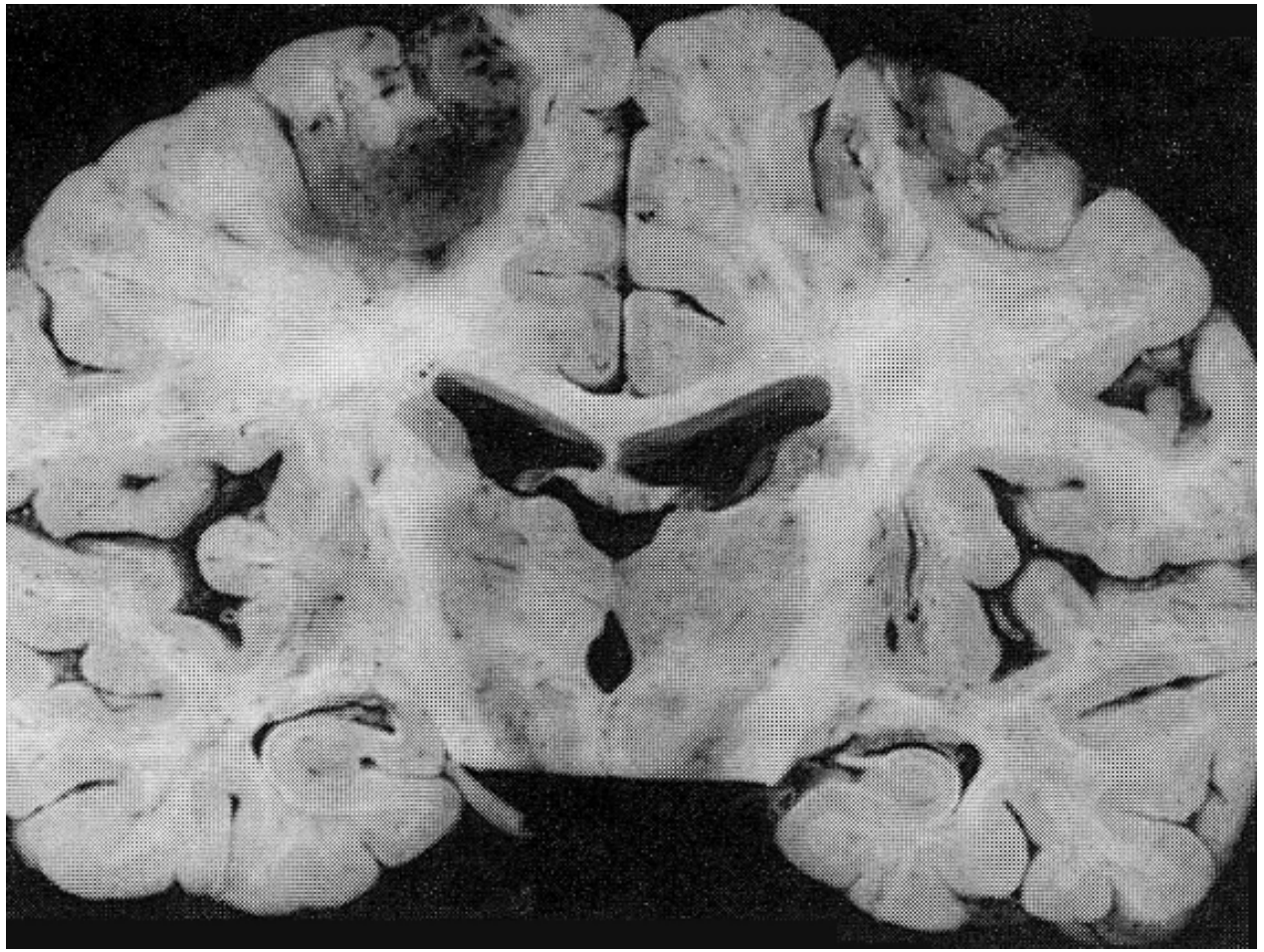
Ito H, et al. *Journal of Cerebral Blood Flow & Metabolism* **2003**; 23:665–670

IPERVENTILAZIONE



Fortune JB. *J Trauma* **1995**; 39:463-472

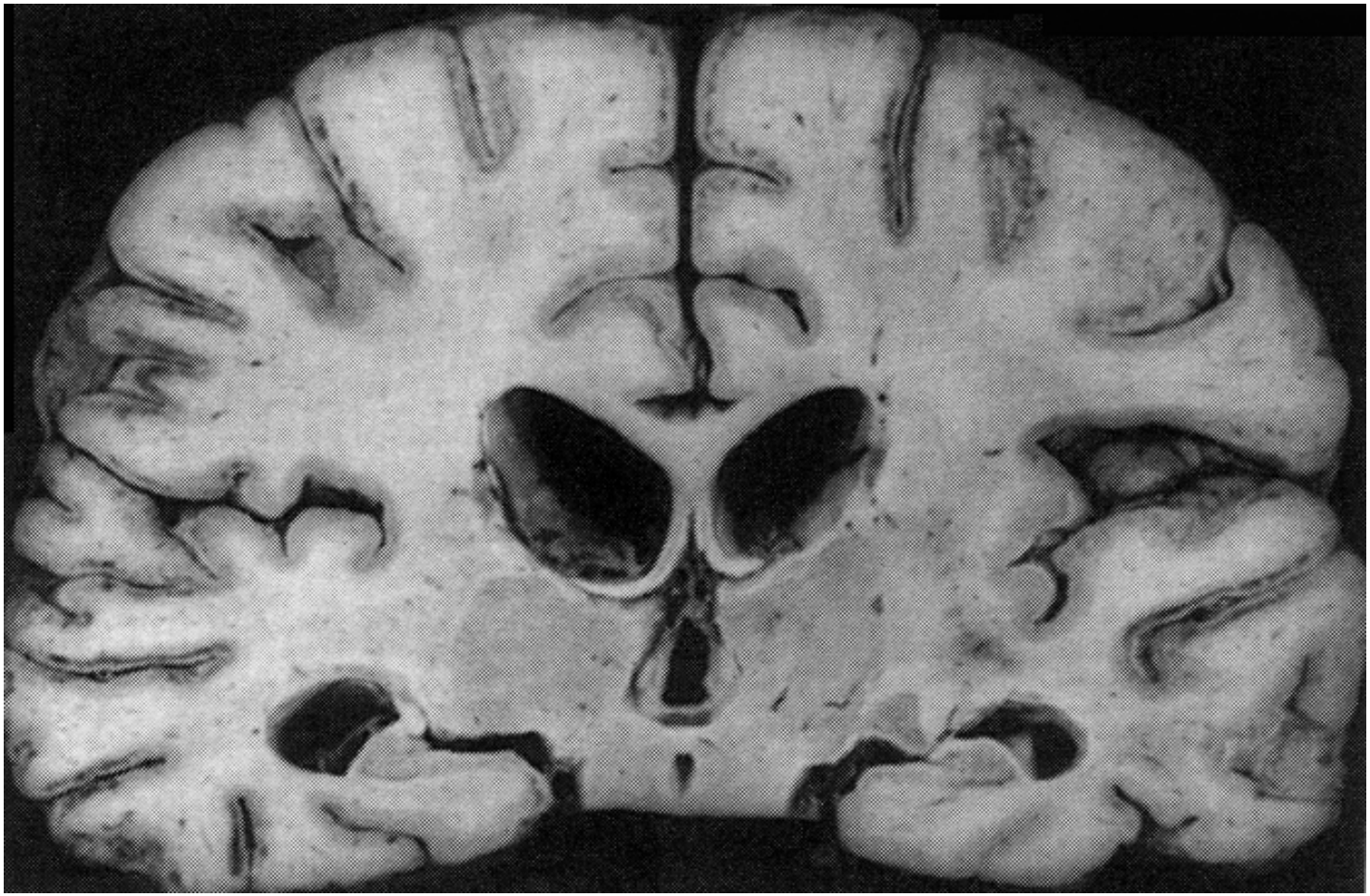
Hypotensive encephalopathy (ischemic)



Cerebral infarction at border zones: hemorragic asymmetric infarction btw the anterior and middle cerebral artery territories

Adams HJ, Graham DI. 1994

Hypoxic-ischemic encephalopathy



Adams HJ, Graham DI. 1994

Case report

BMJ Case Reports

Rare disease

Exercise associated hyponatraemia leading to tonic-clonic seizure

Carl J Reynolds, Barbara J Cleaver, Sarah E Finlay

A 34-year-old Filipino lady presented to the emergency department with breathlessness and muscle cramping following a Bikram yoga workout. The patient reported sweating excessively while performing 90 min of strenuous exertion in a humidified room heated to an ambient temperature of 40.6°C. After the workout she drank 3.5 litres of water before experiencing breathlessness, severe muscle cramps, nausea and general malaise.

Initial investigations revealed severe hyponatraemia (120 mmol/l). Despite early sodium replacement the patient dropped her Glasgow coma scale to 9/15 and developed tonic clonic seizures, requiring intubation and admission to the intensive care unit.

The hyponatraemia was slowly corrected on the intensive care unit and the patient made a full recovery over the course of 5 days.

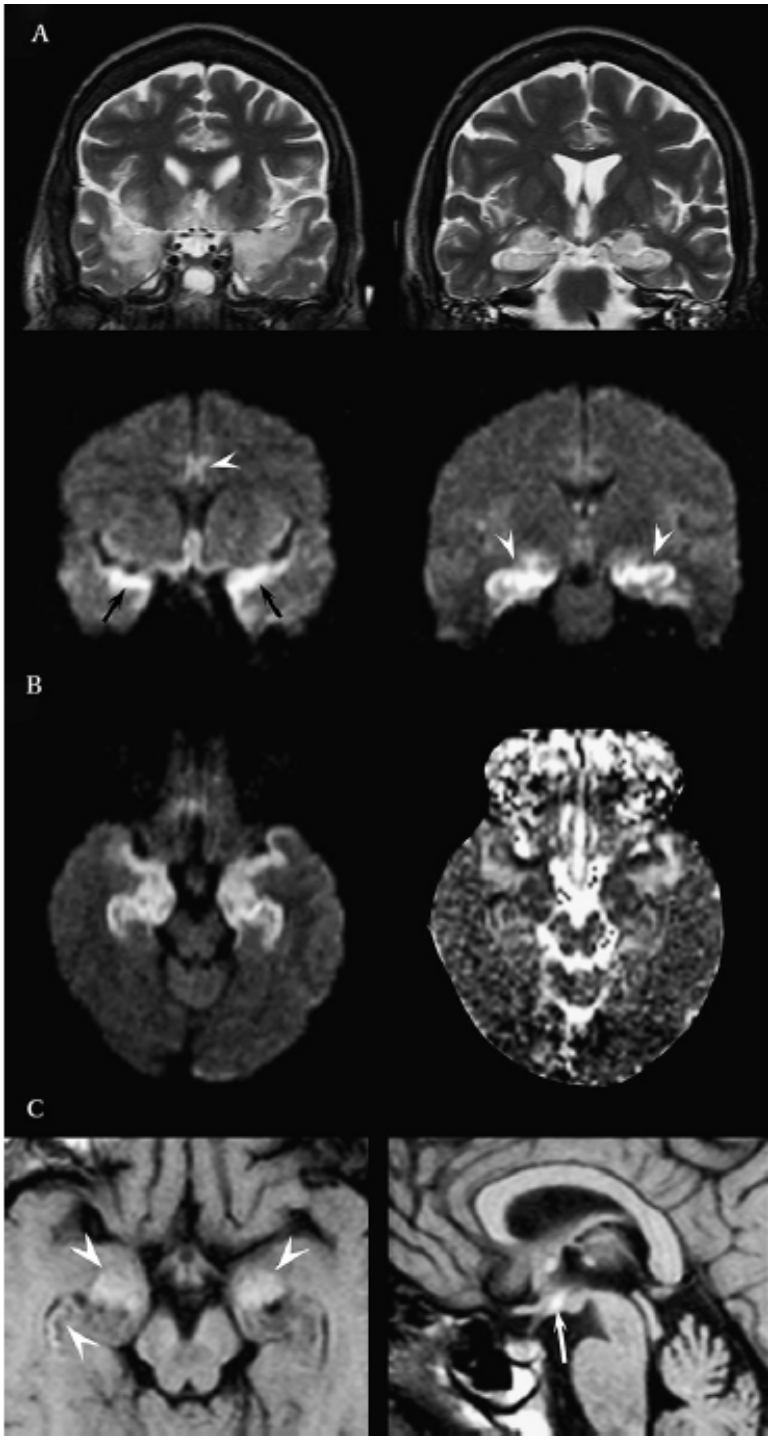
This case highlights the dangers of overzealous fluid replacement following severe exertion in a hot environment.

Limbic system vulnerability to acute severe hypernatraemia

Cagnin A, et al.

J Neurol Neurosurg Psychiatry **2011**;82:588-590.

- Laparoscopic excision of a hydatid cystic liver mass
- Intraperitoneal cyst rupture
- Immediate peritoneal lavage with a **30%** hypertonic saline solution to avoid the cyst content dissemination
- Coma and generalised seizures
- Extreme hypernatraemia (Na 200 mmol/l)
- Coagulative necrosis of the amygdala, hippocampal cortex and hypothalamus
- Staphylococcus aureus septicaemia and death

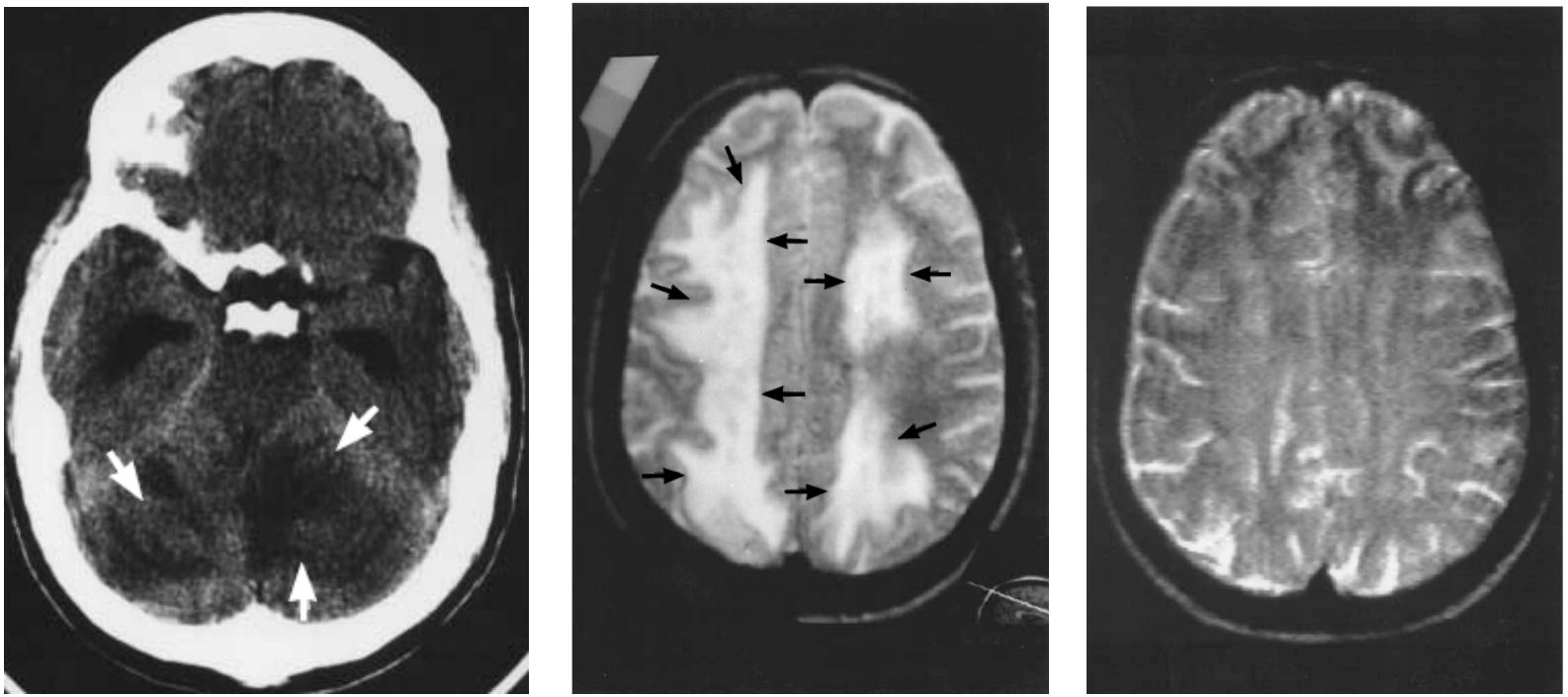


A REVERSIBLE POSTERIOR LEUKOENCEPHALOPATHY SYNDROME

JUDY HINCHEY, M.D., CLAUDIA CHAVES, M.D., BARBARA APPIGNANI, M.D., JOAN BREEN, M.D., LINDA PAO, M.D., ANNABEL WANG, M.D., MICHAEL S. PESSIN, M.D., CATHERINE LAMY, M.D., JEAN-LOUIS MAS, M.D., AND LOUIS R. CAPLAN, M.D.

N Engl J Med **1996**;334:494-500

- A syndrome of headache, altered mental functioning, seizures, and loss of vision
- Reversible, predominantly posterior leukoencephalopathy on neuroimaging
- Renal insufficiency, **hypertension**, immunosuppression



ORIGINAL CONTRIBUTION

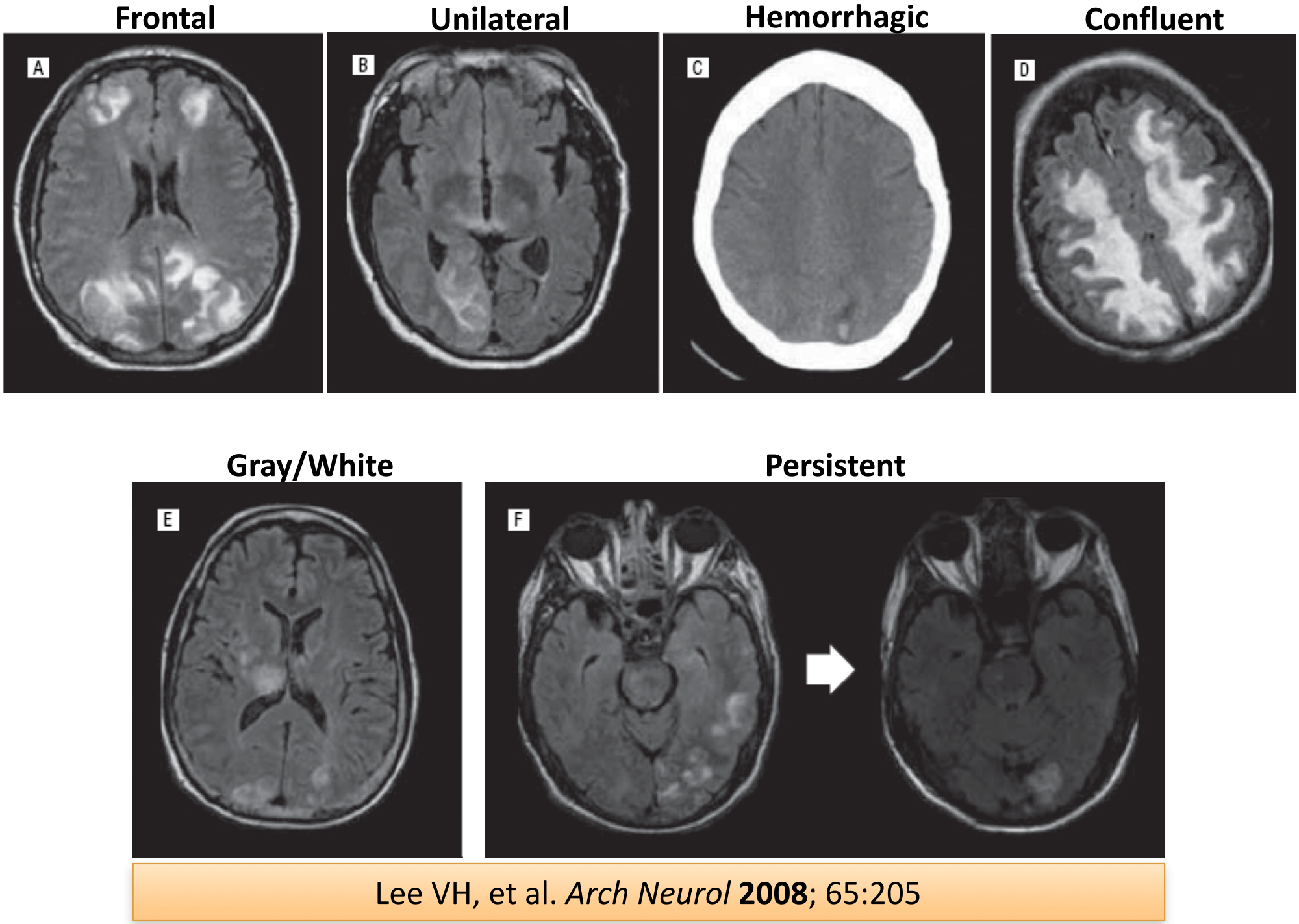
Clinical Spectrum of Reversible Posterior Leukoencephalopathy Syndrome

Vivien H. Lee, MD; Eelco F. M. Wijdicks, MD; Edward M. Manno, MD; Alejandro A. Rabinstein, MD

Arch Neurol **2008**;65(2):205-210

The condition was rarely isolated to the parieto-occipital white matter, and atypical neuroimaging features were frequent.

Frontal involvement	22 (58%),
Gray matter lesions	16 (42%)
Foci of permanent injury	10 (26%)
Unilateral lesions	2 (5%)
Hemorrhage	2 (5%)
Recurrent RPLS	2 (5%)
Confluent lesions	2 (5%)



Lee VH, et al. *Arch Neurol* **2008**; 65:205

THE NEUROLOGICAL COMPLICATIONS OF SEPSIS

The Discovery of Critical Illness Polyneuropathy: A Memoir

Charles Bolton

Can J Neurol Sci **2010**; 70: 37: 431-438

When I first observed patients with critical illness polyneuropathy and we were still puzzling about the underlying etiology, I would often hear the word 'sepsis' mentioned in the ICU. I asked intensivists, "What is this thing called sepsis?"

In 1977, while I was Chief of Clinical Neurological Sciences at Victoria Hospital and Director of the EMG laboratory, William Sibbald, Director of the ICU, asked me to investigate a 56-year old woman.

The woman had been in the ICU for three weeks but could not be weaned from the ventilator.

The electrophysiological studies indicated severe axonal degeneration of motor and sensory fibers.

Brain (1987), **110,** 819–842

CRITICAL ILLNESS POLYNEUROPATHY

A COMPLICATION OF SEPSIS AND MULTIPLE ORGAN FAILURE

by DOUGLAS W. ZOCHODNE,[1] CHARLES F. BOLTON,[1] GEORGE A. WELLS,[4] JOSEPH J. GILBERT,[1,2] ANGELIKA F. HAHN,[1] JOHN D. BROWN[1] *and* WILLIAM A. SIBBALD[3]

(*From the* [1]*Departments of Clinical Neurological Sciences,* [2]*Pathology,* [3]*Internal Medicine, and* [4]*Statistics and Actuarial Sciences, Victoria Hospital, University of Western Ontario, London, Ontario, Canada*)

Critical illness polyneuropathy and myopathy: a major cause of muscle weakness and paralysis

Nicola Latronico, Charles F Bolton

Lancet Neurol **2011**; 10: 931–41

The past 25 years of research have shown that CIP aff ects between a third and half of the most severely critically ill patients, and is the most frequent acute polyneuropathy in intensive care units (ICU).

CIP presents with limb and respiratory muscle weakness and is strongly associated with failed weaning of patients from the ventilator; despite improvement, patients have varying degrees of disability after discharge from the acute care hospital.

CIM is a primary myopathy that is not secondary to muscle denervation, with distinctive electrophysiological and morphological findings. The clinical features are often much the same as for CIP.

CIP and CIM are most often combined.

Neurocritical care medicine

is part of everyday general critical care practice

What else

DEAD OR ALIVE ?

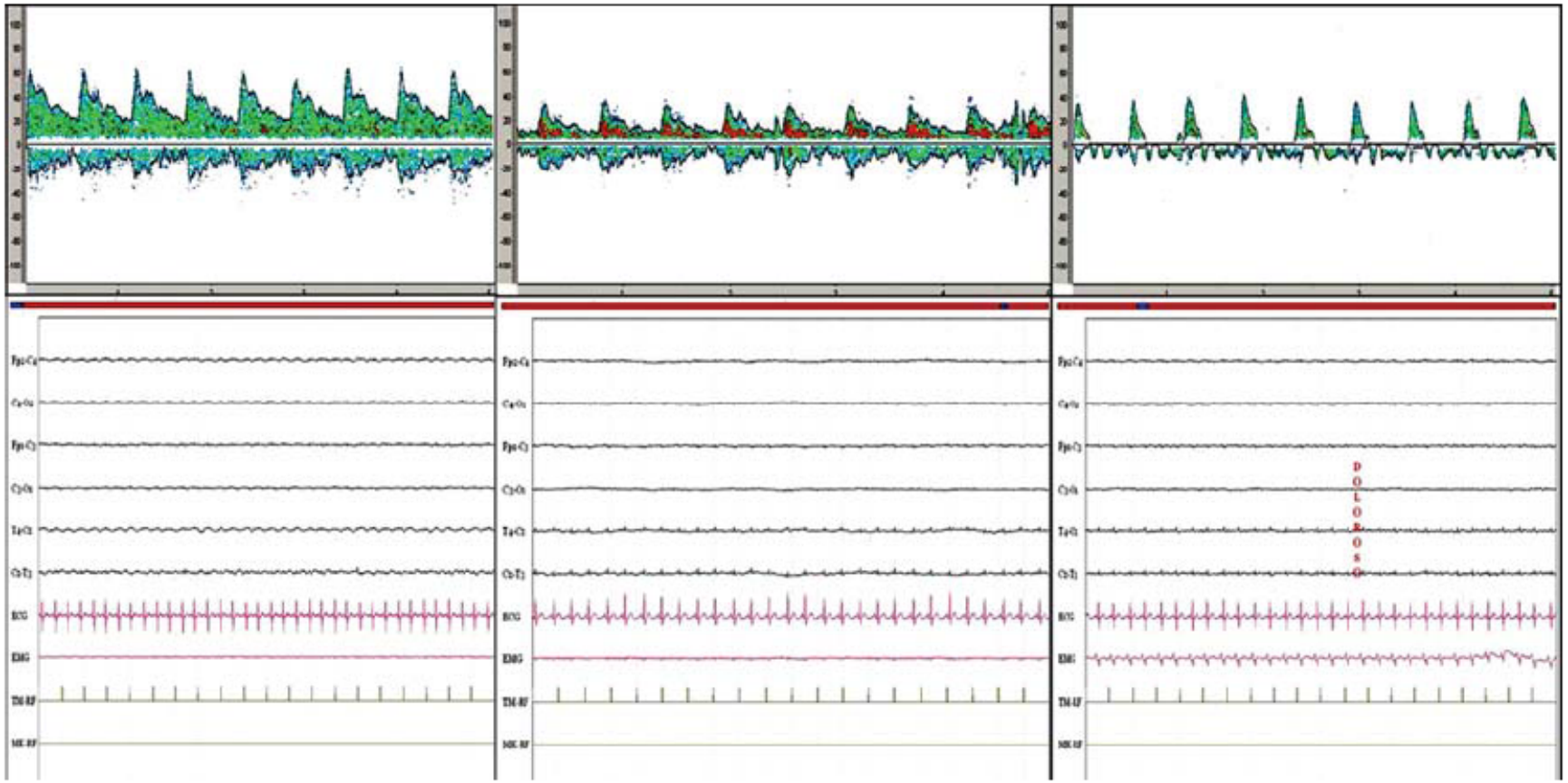
In 1981, there were seven different brain death statutes. So theoretically (but not really) you could put someone in an ambulance in California and drive them across the country to Pennsylvania and they'd be dead, alive, alive, dead, alive, dead, dead, alive, dead, dead, and arrive in Pennsylvania alive.

That's ridiculous. Our death criteria must be uniform - you can't be de ad in one state and alive in another state.

The "right to die" in America: sloganeering from Quinlan and Cruzan to Quill and Kevorkian
George J Annas
Duquesne Law Rev **1996**; 34: 875–897

Brainstem death

BRAIN DYING



20 hours

Persistent CBF and EEG

Dead in the UK
Alive in Italy and Sweden

6 hours

Persistent CBF, flat EEG

Dead in the UK and in Italy
Alive in Sweden

Absent CBF, flat EEG

Dead for all (?)

Rasulo F, et al. Brain dying. *Br J Anaesth* **2010**;105:870-1

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PLoS one

Quality of Reporting on the Vegetative State in Italian Newspapers. The Case of Eluana Englaro

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PLoS ONE **2011**; 6(4): e18706.

On February 2, 2009 Eluana was transferred to La Quiete, a private nursing home in Udine, to withdraw ANH.

On February 6, 2009, the withdrawal protocol started. Eluana Englaro died on February 9, 2009, at 19:35, while the Italian Senate was holding **a turbulent emergency session** to pass a bill forcing doctors to resume AHN.

The decision to withdraw AHN became the crossroads at which law, politics, religion, and medicine collided, attracting attention at the highest levels of political power

Latronico N, et al. Quality of Reporting on the Vegetative State in Italian Newspapers. The Case of Eluana Englaro. *PLoS ONE* **2011**;6(4):e18706

Reversible brain death after cardiopulmonary arrest and induced hypothermia

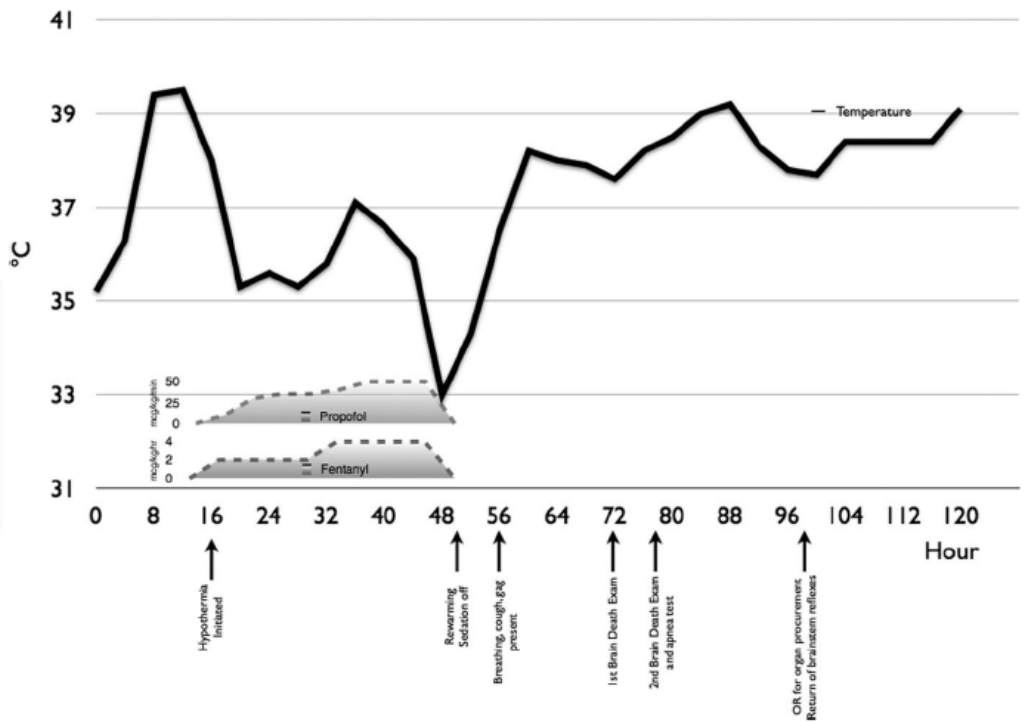
Webb AC, Samuels OB

Crit Care Med **2011**; 39: online first

Cardiopulmonary resuscitation was performed, spontaneous perfusion restored, and therapeutic hypothermia was attempted for neural protection. Over 24 hrs, remaining cranial nerve function was lost. The neurologic examination was consistent with brain death.

Apnea test and repeat clinical examination after a duration of 6 hrs confirmed brain death.
Death was pronounced and the family consented to organ donation.

24 hrs after brain death pronouncement, on arrival to the operating room for organ procurement, the patient was found to have regained corneal reflexes, cough reflex, and spontaneous respirations.



We fully agree with Webb and Samuels that there should be extreme caution diagnosing brain death immediately after therapeutic hypothermia.

In fact, no neurologist should even try.

Wijdicks EFM; Varelas PN, Gareth S. Gronseth GS. **There is no reversible brain death**. *Crit Care Med* **2011**; 39: 2204-2205

What is Neurocritical Care Medicine

THE NEUROCRITICAL CARE PHYSICIAN

Competency & Knowledge

- Neurology
- General intensive care medicine
- Anesthesia
- Clinical research
- Basic research
- Neuro-ethics

- Prudence