Electrographic status epilepticus is associated with mortality and worse short-term outcome in critically ill children.

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Abstract

OBJECTIVE: Electrographic seizures and electrographic status epilepticus are common in critically ill children. We aimed to determine whether electrographic seizures and electrographic status epilepticus are associated with higher mortality or worse short-term neurologic outcome.

DESIGN: Prospective observational study PICU of a tertiary children's hospital

PATIENTS: Non-neonatal children admitted to a PICU with acute encephalopathy underwent continuous electroencephalographic monitoring. Electroencephalographs were scored as 1) no seizures, 2) electrographic seizures, or 3) electrographic status epilepticus. Covariates included age, acute neurologic disorder category, prior neurodevelopmental status, sex, and electroencephalographic background category. Outcomes were mortality and worsening of pediatric cerebral performance category from preadmission to PICU discharge. Chi-square analysis, Fisher's exact test, and multivariable logistic regression were used to evaluate the associations between electrographic seizures or electrographic status epilepticus and mortality or short-term neurologic outcome, using odds ratios and 95% confidence intervals.

RESULTS: Two hundred children underwent continuous electroencephalographic monitoring. Eighty-four (42%) had seizures, which were categorized as electrographic seizures in 41 (20.5%) and electrographic status epilepticus in 43 (21.5%). Thirty-six subjects (18%) died, and 88 subjects (44%) had pediatric cerebral performance category worsening. In multivariable analysis, electrographic status epilepticus was associated with an increased risk of mortality (odds ratio 5.1; 95% confidence interval 1.4, 18; p = 0.01) and pediatric cerebral performance category worsening (odds ratio 17.3; 95% confidence interval 3.7, 80; p < 0.001), whereas electrographic seizures were not associated with an increased risk of mortality (odds ratio 1.3; 95% confidence interval 0.3, 5.1; p = 0.74) or pediatric cerebral performance category worsening (odds ratio 1.2; 95% confidence interval 0.4, 3.9; p = 0.77).

CONCLUSIONS. Electrographic status epilepticus, but not electrographic seizures, is associated with mortality and worse short-term neurologic outcome in critically ill children with acute encephalopathy.

Publication	Crit Care Med
Volume	41(1)
Pages	215-23
Date	Jan 2013
DOI	10.1097/CCM.0b013e3182668035.

Critical care of poor-grade subarachnoid hemorrhage

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Abstract

PURPOSE OF REVIEW Early aggressive treatment of poor-grade subarachnoid hemorrhage patients has resulted in more favorable long-term outcomes. This article covers the aspects of neurocritical care management directed to the patient with poor-grade subarachnoid hemorrhage (Hunt and Hess 4 and 5) and outlines important prognostic features.

RECENT FINDINGS: Immediate cardiopulmonary and neurological support, early aneurysm repair, neuromodality and multimodality monitoring under the care of neurointensivists, treatment of medical complications, prevention and appropriate management of delayed cerebral ischemia have improved long-term outcomes after poor-grade subarachnoid hemorrhage. This includes control of intracranial hypertension, optimization of cerebral perfusion pressure and cardiac hemodynamics, correction of electrolyte abnormalities, and management of complications. Global cerebral edema, acute ischemic injury seen on diffusion-weighted imaging, and early vasospasm are disease states in the poor-grade patients that require attention and further investigation. Monitoring techniques such as surface and intracortical continuous electroencephalography, brain tissue oxygen monitoring, and microdialysis may detect secondary brain injury in a potentially reversible state.

SUMMARY: Poor-grade subarachnoid hemorrhage patients have the potential to recover and should therefore be fully resuscitated and treated aggressively with the available standards and monitoring techniques.

Publication Current Opinion in Critical Care
Volume 17
Issue 2
Pages 85-93
Date Apr 2011
Journal Abbr Curr Opin Crit Care
DOI 10.1097/MCC.0b013e328342f83d
ISSN 1531-7072
URL http://www.ncbi.nlm.nih.gov/pubmed/21178613

Tags: Brain Ischemia, Critical Care, Female, Humans, Male, Prognosis, Subarachnoid Hemorrhage

Artifact: recording EEG in special care units

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Abstract

PURPOSES: Artifacts may be obtained during routine recording but are more common in special care units (SCUs) outside of the EEG laboratory, where complex electrical currents are present that create a "hostile" environment. Special care units include the epilepsy monitoring unit, neurologic intensive care unit, and operating room, where artifact is present in virtually every recording, increasing with prolonged use. Nonepileptic attacks treated as epileptic seizures have been incorrectly diagnosed and treated due to a misinterpreted EEG. The recent emergence of continuous EEG as a neurophysiologic surrogate for brain function in the neurologic intensive care unit and operating room has also brought a greater amount and new types of EEG artifact.

CONCLUSIONS. The artifacts encountered in special care units during continuous EEG are becoming more complex and may have adverse therapeutic implications. Our knowledge of artifact needs to parallel our growth in technology to avoid the pitfalls that may be incurred during visual analysis of the EEG

Publication	Journal of Clinical Neurophysiology: Official Publication of the American Electroencephalographic Society
Volume	28
Issue	3
Pages	264-277
Date	Jun 2011
Journal Abbr	J Clin Neurophysiol
DOI	10.1097/WNP.
ISSN	1537-1603
Short Title	Artifact
URL	http://www.ncbi.nlm.nih.gov/pubmed/21633252

Tags: Artifacts, Brain, Brain Diseases, Critical Care, Electroencephalography, Humans, Intensive Care

Continuous video-EEG monitoring in pediatric intensive care units

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Abstract

PURPOSE Several studies indicate a higher occurrence than might be expected of seizures in intensive care unit patients, many of which are not clinically apparent. Few of these studies are devoted exclusively to pediatric patients. The purpose of this study is to determine the occurrence of seizures in a cohort of pediatric and neonatal intensive care unit patients.

METHODS Long-term video electroencephalography (EEG) monitoring studies performed in the pediatric and neonatal intensive care units were reviewed. Age, gender, diagnosis, EEG background, epileptiform activity, time of onset and duration of seizures, presence of electroclinical or electrographic seizures, and survival were collected.

KEY FINDINGS One hundred thirty-eight recordings encompassing 122 patients were identified. Thirty-four percent of the sessions identified seizures in the first 24 h (38% of the cohort experienced a seizure at some time during monitoring, which ranged from 1-22 days): 17% captured only electroclinical seizures, 49% were electrographic only, and 34% had both electroclinical and electrographic seizures. Seventy percent of those patients experiencing seizures had their first seizure within the first hour of EEG recording. Younger age and epileptiform activity (including periodic) were associated with the occurrence of seizures. Diagnoses of head trauma and status epilepticus/recent prior seizure were more likely than other at-risk diagnoses to be associated with seizures; cardiac arrest managed with hypothermia was less likely to be associated with seizures. One-fourth of the recordings identified nonepileptic events.

SIGNIFICANCE Seizures occurred in one-third of critically ill pediatric patients at risk for seizures who underwent video-EEG monitoring, and many of these seizures did not have a clinical correlate. In those at risk for seizures in intensive care units, there should be a low threshold

Publication	Epilepsia
Volume	52
Issue	6
Pages	1130-1136
Date	Jun 2011
Journal Abbr	Epilepsia
DOI	10.1111/j.1528-1167.2011.03070.x
ISSN	1528-1167
URL	http://www.ncbi.nlm.nih.gov/pubmed/21671924

Tags Adolescent, Child, Child, Preschool, Cohort Studies, Electroencephalography, Female, Humans, Infant, Infant, Newborn, Intensive Care Units, Neonatal, Intensive Care Units, Pediatric, Male, Monitoring, Physiologic, Risk Factors, Seizures, Time Factors, Video Recording

Electroencephalography in clinical epilepsy research

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Abstract

Electroencephalography (EEG) remains central to the investigation of epilepsy. This review discusses two clinical problems at the temporal extremes of neurophysiologic recording: evaluation of the clinical significance of individual spike discharges in benign epilepsy of childhood with centrotemporal spikes (BECTS), and prolonged (several days) continuous EEG monitoring in the ICU. BECTS is misdiagnosed often, and probably mis-treated often as well. Though the long-term outcome is usually excellent, it remains unclear whether the individual epileptiform discharges have a clinical effect. Answering this question is difficult, in part because of the natural evolution of the epilepsy and its different appearance depending on wakefulness or sleep state, and also due to substantial methodologic problems in measuring short and long-term cognitive effects.

Continuous EEG (CEEG) recording has grown remarkably over the last 10 years. It has proved crucial in the diagnosis of nonconvulsive status epilepticus (NCSE), especially in the ICU, given the usual lack of obvious clinical signs of seizures in most of these patients, many of whom are critically ill. Much progress has been made in agreeing on terminology for the EEG findings, but diagnosis is still complicated. More efficient and reliable technology is being developed to help process the massive amount of data captured by CEEG and make it more useful (and in a timely fashion) clinically. Still, it is not completely clear which patients should be monitored, for how long, and what is the best role for CEEG in assessing and adjusting treatment once the diagnosis has been made. Investigators are using CEEG to study "seizure burden," to help determine what are the long-term effects of nonconvulsive seizures and NCSE, and to help

Publication	Epilepsy & Behavior: E&B
Volume	22
Issue	1
Pages	126-133
Date	Sep 2011
Journal Abbr	Epilepsy Behav
DOI	10.1016/j.yebeh.2011.06.009
ISSN	1525-5069
URL	http://www.ncbi.nlm.nih.gov/pubmed/21824821

Tags Biomedical Research, Electroencephalography, Epilepsy, Epilepsy, Rolandic, Humans, Intensive Care Units, Monitoring, Physiologic

High prevalence of nonconvulsive and subtle status epilepticus in an ICU of a tertiary care center: a three-year observational cohort study

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Abstract

BACKGROUND Status epilepticus is one of the most important neurological emergencies and requires immediate therapy and admission to the intensive care unit. We hypothesized that nonconvulsive and subtle status epilepticus are more frequent than reported.
METHODS This observational cohort study describes types, courses, duration, length of hospital stay, outcome and case fatality rate of status epilepticus in adults in relation to demographic and clinical variables. It was conducted in an intensive care unit of a tertiary care center over three years.
RESULTS 111 status epilepticus episodes had a median duration of 48h. Hospitalization length was 18±15.3 days. 81% of the status epilepticus episodes were nonconvulsive and subtle. Case fatality rate was 17%. Age over 70 years had independent positive influence on status epilepticus course (OR: 5.135; p=0.0029). Hospital stay increased by 1.13h with each additional hour of status epilepticus (p=0.02). Subtle status epilepticus was a risk factor for refractoriness (p=0.0065).
CONCLUSIONS Prevalence of nonconvulsive and subtle status epilepticus was higher than reported, emphasizing the importance of clinical awareness. Older age was associated with more favorable course. This unexpected and contradictory result has to be taken into account during therapeutic interventions in the elderly and should warn from early.

Publication	Epilepsy Research
Volume	96
Issue	1-2
Pages	140-150
Date	Sep 2011
Journal Abbr	Epilepsy Res.
DOI	10.1016/j.eplepsyres.2011.05.018
ISSN	1872-6844
Short Title	High prevalence of nonconvulsive and subtle status epilepticus in an ICU of a tertiary
URL	http://www.ncbi.nlm.nih.gov/pubmed/21676592

Tags Adult, Aged, Aged 80 and over, Algorithms, Anticonvulsants, Cohort Studies Electroencephalography, Female Hospitalization, Hospitals, Humans, Intensive Care Units, Length of Stay, Male, Middle Aged, Observation, Outcome Assessment (Health Care), Prevalence, Retrospective Studies, Statistics, Nonparametric, Status Epilepticus, Switzerland, Young Adult

Continuous Electroencephalography (cEEG) Changes Precede Clinical Changes in a Case of Progressive Cerebral Edema

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Abstract

BACKGROUND: Continuous electroencephalogram (cEEG) is tightly linked to cerebral metabolism and is sensitive to cerebral ischemia and hypoxia. The severity of cerebral ischemia can be seen on cEEG as changes in morphology, amplitude, or frequency, and cEEG may detect neuronal dysfunction at a reversible stage.
METHODS: Case report and imaging.
RESULTS: We present a case of focal cerebral edema with changes seen on cEEG 24 h before clinical signs of increased intracranial pressure. cEEG showed developing asymmetry in the left hemisphere followed by burst suppression. The right hemisphere showed similar progression to burst suppression. Complete suppression of both hemispheres was noted 6 h before clinical signs of herniation. Computed tomography (CT) head confirmed a large left parietal intracerebral hematoma with mass effect.
CONCLUSIONS: cEEG has applications in monitoring cerebral dysfunction in addition to detecting seizure activity in the intensive care unit. It may serve a vital role in multi-modality monitoring for early recognition of neurological complications from brain injuries that may not be noticed clinically, which is paramount to early intervention.

Publication	Neurocritical Care
Date	Nov 23, 2011
Journal Abbr	Neurocrit Care
DOI	10.1007/s12028-011-9650-4
Pages	1556-0961
URL	http://www.ncbi.nlm.nih.gov/pubmed/22108782

The impact of EEG in the diagnosis and management of patients with acute impairment of consciousness

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Abstract

OBJECTIVES To assess the frequency of electroencephalogram (EEG) requests in the emergency room (ER) and intensive care unit (ICU) for patients with impairment of consciousness (IC) and its impact in the diagnosis and management.
METHODS We followed patients who underwent routine EEG from ER and ICU with IC until discharge or death.
RESULTS During the study, 1679 EEGs were performed, with 149 (8.9%) from ER and ICU. We included 65 patients and 94 EEGs to analyze. Epileptiform activity was present in 42 (44.7%). EEG results changed clinical management in 72.2% of patients. The main reason for EEG requisition was unexplained IC, representing 36.3% of all EEGs analyzed. Eleven (33%) of these had epileptiform activity.
CONCLUSION EEG is underused in the acute setting. The frequency of epileptiform activity was high in patients with unexplained IC. EEG was helpful in confirming or ruling out the suspected initial diagnosis and changing medical management in 72% of patients.

Publication	Arquivos De Neuro-Psiquiatria
Volume	70
Issue	1
Pages	34-39
Date	Jan 2012
Journal Abbr	Arq Neuropsiquiatr
ISSN	1678-4227
URL	http://www.ncbi.nlm.nih.gov/pubmed/22218471

Quantitative EEG analysis for automated detection of nonconvulsive seizures in intensive care units

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Abstract

PURPOSES Because of increased awareness of the high prevalence of nonconvulsive seizures in critically ill patients, use of continuous EEG (cEEG) monitoring is rapidly increasing in ICUs. However, cEEG monitoring is labor intensive, and manual review and interpretation of the EEG are impractical in most ICUs. Effective methods to assist in rapid and accurate detection of nonconvulsive seizures would greatly reduce the cost of cEEG monitoring and enhance the quality of patient care.
METHODS In this study, we report a preliminary investigation of a novel ICU EEG analysis and seizure detection algorithm. Twenty-four prolonged cEEG recordings were included in this study. Seizure detection sensitivity and specificity were assessed for the new algorithm and for the two commercial seizure detection software systems.
RESULTS The new algorithm performed with a mean sensitivity of 90.4% and a mean false detection rate of 0.066/hour. The two commercial detection products performed with low sensitivities (12.9 and 10.1%) and false detection rates of 1.036/hour and 0.013/hour, respectively.
CONCLUSIONS These findings suggest that the novel algorithm has potential to be the basis of clinically useful software that can assist ICU staff in timely identification of nonconvulsive seizures. This study also suggests that currently available seizure detection software does not perform sufficiently in detection of nonconvulsive seizures in critically ill patients. This article is part of a Supplemental Special Issue entitled The Future of Automated Seizure Detection and Prediction.

Publication	
Volume	
Issue	
Pages	
Date	
Journal Abbr	
DOI	
ISSN	
Short Title	
URL	

Tags

Continuous video-EEG monitoring increases detection rate of nonconvulsive status epilepticus in the ICU

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Abstract

PURPOSE Status epilepticus (SE) is an important neurologic emergency requiring treatment on an intensive care unit (ICU). Although convulsive SE is self-evident, the diagnosis of nonconvulsive SE (NCSE) depends on electroencephalography (EEG) confirmation. Previous work showed that 82% of patients with SE had NCSE in our ICU. We hypothesize that continuous video-EEG monitoring (CVEM) may increase the diagnostic yield in patients with SE, especially NCSE, and leave fewer patients undiagnosed.

METHODS We retrospectively assessed the EEG reports of 537 patients with suspected SE during three comparable 9-month periods, two groups before (groups 1 and 2) and one (group 3) after CVEM introduction. Differences in monthly rates of SE between groups were assessed using the Mann-Whitney U-test.

KEY FINDINGS The rates of diagnosis increased significantly after implementation of CVEM ($p = 0.0546$). There was no significant difference in monthly rates of NCSE diagnosis between groups 2 and 1 (difference = 0.78 new diagnosis/month; $p = 0.374$). Differences between groups 3 and 2 (2.89; $p = 0.0173$), between groups 3 and 1 (3.67; $p = 0.006$) and between group 3 and pooled groups 1 and 2 (3.28; $p = 0.002$) were statistically significant.

SIGNIFICANCE Frequency of NCSE diagnosis increased significantly after implementation of CVEM and was higher than the increment of performed investigations alone. Such an effect may result from the combination of longer observation periods during CVEM, greater and permanent availability of EEG recordings, and heightened awareness of NCSE. Future studies may corroborate improvement of diagnosis and outcomes in patients with disorders of consciousness by CVEM.

Publication	Epilepsia
Volume	52
Issue	3
Pages	453-457
Date	Mar 2011
Journal Abbr	Epilepsia
DOI	10.1111/j.1528-1167.2010.02888.x
ISSN	1528-1167
URL	http://www.ncbi.nlm.nih.gov/pubmed/21204818

Tags Adolescent, Adult, Aged, Aged, 80 and over, Comorbidity, Electroencephalography, Female, Humans, Intensive Care Units, Male, Middle Aged, Monitoring, Physiologic, Retrospective Studies, Sensitivity and Specificity, Signal Processing, Computer-Assisted, Status Epilepticus, Video Recording, Young Adult

Monitoring of brain function in anesthesia and intensive care

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Abstract

PURPOSE OF REVIEW Despite its obvious importance, the brain is inconsistently the focus of monitoring in anesthesia and intensive care settings. However, there are multiple modalities available to address cerebral monitoring that when acted upon, may improve perioperative outcomes. This review addresses the various brain monitoring options that can be integrated in anesthetic and intensive care practice in order to optimize perioperative outcomes.

RECENT FINDINGS Although numerous monitoring modalities are available, the level of evidence supporting each application is somewhat limited with few of the available monitors having been subjected to large-scale randomized trials. Despite this, they each may have a potential role to play in providing information that can be integrated to optimize care.

SUMMARY Using a comprehensive cerebral monitoring strategy may optimize outcomes in anesthetic and intensive care.

Publication	Current Opinion in Anaesthesiology
Volume	23
Issue	6
Pages	759-764
Date	Dec 2010
Journal Abbr	Curr Opin Anaesthesiol
DOI	10.1097/ACO.0b013e3283404641
ISSN	1473-6500
URL	http://www.ncbi.nlm.nih.gov/pubmed/20930619

Tags Anesthesia, General, Brain, Electroencephalography, Evoked Potentials, Humans, Intensive Care, Monitoring, Intraoperative, Oximetry Oxygen, Ultrasonography, Doppler, Transcranial

What's shaking in the ICU? The differential diagnosis of seizures in the intensive care setting

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Abstract

PURPOSES: To analyze what conditions mimic seizures in the intensive care unit (ICU) setting, we reviewed all bedside electroencephalography (EEG)-videos obtained in the adult ICU setting over an 18-month period. Only those studies performed for "possible seizures" due to motor phenomena and whose clinical events were captured on video were analyzed.

RESULTS: A total of 52 studies were performed. Fourteen patients (27%) had epileptic seizures. Thirty-eight (73%) had nonepileptic events. These consisted of 12 (23%) with tremor-like movements, 7 (13.5%) with multifocal myoclonic jerks without electrographic changes, 7 (13.5%) with slow semipurposeful movements, and 10 with other movements.

CONCLUSIONS Therefore, seizure mimics in the ICU setting were diverse and distinct from the usual differential diagnosis of seizures seen in ambulatory patients.

Publication	Epilepsia
Volume	51
Issue	11
Pages	2338-2340
Date	Nov 2010
Journal Abbr	Epilepsia
DOI	10.1111/j.1528-1167.2010.02683.x
ISSN	1528-1167
Short Title	What's shaking in the ICU?
URL	http://www.ncbi.nlm.nih.gov/pubmed/20738384

Tags Adolescent, Adult, Aged, Aged, 80 and over, Diagnosis, Differential, Electroencephalography, Epilepsy, Female, Humans, Intensive Care Units, Male, Middle Aged, Motor Activity, Myoclonus, Point-of-Care Systems, Retrospective Studies, Seizures, Signal Processing, Computer-Assisted, Tremor, Video Recording, Young Adult

Urgent continuous EEG (cEEG) monitoring leads to changes in treatment in half of cases

Author	Lawrence J Hirsch
Location	
Abstract	**PURPOSE**: Published comments to 'How Seizure Detection by Continuous Electroencephalographic Monitoring Affects the Prescribing of Antiepileptic Medications." Kilbride RD, et. al. Arch Neurol 2009;66(6):723–728. **OBJECTIVES:** To assess the effect of continuous electroencephalographic monitoring on the decision to treat seizures in the inpatient setting, particularly in the intensive care unit. DESIGN: Retrospective cohort study. **SETTING**: Medical and neuroscience intensive care units and neurological wards. PATIENTS: Three hundred consecutive nonelective continuous electroencephalographic monitoring studies, performed on 287 individual inpatients over a 27-month period. **MAIN OUTCOME MEASURES**: Epileptiform electroencephalographic abnormalities and changes in antiepileptic drug (AED) therapy based on the electroencephalographic findings. RESULTS: The findings from the continuous electroencephalographic monitoring led to a change in AED prescribing in 52% of all studies with initiation of an AED therapy in 14%, modification of AED therapy in 33%, and discontinuation of AED therapy in 5% of all studies. Specifically, the detection of electrographic seizures led to a change in AED therapy in 28% of all studies. **CONCLUSIONS:** The findings of continuous electroencephalographic monitoring resulted in a change in AED prescribing during or after half of the studies performed. Most AED changes were made as a result of the detection of electrographic
Publication	Epilepsy Currents / American Epilepsy Society
Volume	10
Issue	4
Pages	82-85
Date	Jul 2010
Journal Abbr	Epilepsy Curr
DOI	10.1111/j.1535-7511.2010.01364.x
ISSN	1535-7511
URL	http://www.ncbi.nlm.nih.gov/pubmed/20697500

Tags

EEG artifacts in the intensive care unit setting

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Abstract	Obtaining a quality EEG in the intensive care unit (ICU) is a very rewarding experience for the EEG technologist. "Quality" is defined as a measure of excellence or state of being free from defects. It takes more than knowing how to obtain a quality record; it takes hands-on experience and time. Electroencephalography is a valuable neurodiagnostic tool in critically ill patients. However, the ICU is a challenging environment to obtain a high quality EEG tracing because artifacts are exceedingly common. Dealing with artifact effectively is an essential function of the EEG technologist. The goal of this paper is to review both physiological and nonphysiological artifacts commonly encountered in an ICU setting. How to recognize, troubleshoot, and prove that an EEG pattern is an artifact will be reviewed for the novice EEG technologist.

Publication	American Journal of Electroneurodiagnostic Technology
Volume	50
Issue	1
Pages	8-25
Date	Mar 2010
Journal Abbr	Am J Electroneurodiagnostic Technol
ISSN	1086-508X
URL	http://www.ncbi.nlm.nih.gov/pubmed/20361716

Tags Artifacts, Electrodes, Electroencephalography, Equipment Failure Analysis, Intensive Care, Reproducibility of Results, Sensitivity and Specificity, Signal Processing, Computer-Assisted

Prognostication after cardiac arrest and hypothermia: a prospective study

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Abstract

OBJECTIVE Current American Academy of Neurology (AAN) guidelines for outcome prediction in comatose survivors of cardiac arrest (CA) have been validated before the therapeutic hypothermia era (TH). We undertook this study to verify the prognostic value of clinical and electrophysiological variables in the TH setting.
METHODS A total of 111 consecutive comatose survivors of CA treated with TH were prospectively studied over a 3-year period. Neurological examination, electroencephalography (EEG), and somatosensory evoked potentials (SSEP) were performed immediately after TH, at normothermia and off sedation. Neurological recovery was assessed at 3 to 6 months, using Cerebral Performance Categories (CPC).
RESULTS Three clinical variables, assessed within 72 hours after CA, showed higher false-positive mortality predictions as compared with the AAN guidelines: incomplete brainstem reflexes recovery (4% vs 0%), myoclonus (7% vs 0%), and absent motor response to pain (24% vs 0%). Furthermore, unreactive EEG background was incompatible with good long-term neurological recovery (CPC 1-2) and strongly associated with in-hospital mortality (adjusted odds ratio for death, 15.4; 95% confidence interval, 3.3-71.9). The presence of at least 2 independent predictors out of 4 (incomplete brainstem reflexes, myoclonus, unreactive EEG, and absent cortical SSEP) accurately predicted poor long-term neurological recovery (positive predictive value = 1.00); EEG reactivity significantly improved the prognostication.

INTERPRETATION Our data show that TH may modify outcome prediction after CA, implying that some clinical features should be interpreted with more caution in this setting as compared with the AAN guidelines. EEG background reactivity is useful in determining the prognosis after CA treated with TH.

Publication	Annals of Neurology
Volume	67
Issue	3
Pages	301-307
Date	Mar 2010
Journal Abbr	Ann. Neurol.
DOI	10.1002/ana.21984
ISSN	1531-8249
Short Title	Prognostication after cardiac arrest and hypothermia
URL	http://www.ncbi.nlm.nih.gov/pubmed/20373341

Tags: Adolescent, Adult, Aged, Aged, 80 and over, Brain, Death, Sudden, Cardiac, Diagnostic Errors, Electroencephalography, Evoked Potentials, Somatosensory, False Positive Reactions, Female, Humans, Hypothermia, Induced, Hypoxia-Ischemia, Brain, Male, Middle Aged, Neural Conduction, Neurologic Examination, Persistent Vegetative State, Practice Guidelines as Topic, Predictive Value of Tests, Prognosis, Prospective Studies, Recovery of Function, Young Adult

A case of near-drowning: a case for routine cerebral monitoring

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Abstract

A 6-week-old infant presenting with near-drowning was medically paralysed and ventilated on admission. Status epilepticus was found on cerebral function monitoring, without which the diagnosis would have been missed or delayed for many hours. This case illustrates the value of cerebral function monitoring for patients in intensive care, where clinical signs of seizure activity are frequently masked by paralysis and sedation. Conclusion: Limited availability of electroencephalogram (EEG) and cerebral function monitoring (CFM) in paediatric intensive care may inadvertently delay diagnosis and appropriate treatments and so adversely affect outcomes.

CONCLUSION: We propose that round-the-clock cerebral function and/or EEG monitoring should be available in all centres that provide paediatric intensive care.

Publication	Acta Paediatrica (Oslo, Norway: 1992)
Volume	99
Issue	3
Pages	463-466
Date	Mar 2010
Journal Abbr	Acta Paediatr.
DOI	10.1111/j.1651-2227.2009.01556.x
ISSN	1651-2227
Short Title	A case of near-drowning
URL	http://www.ncbi.nlm.nih.gov/pubmed/19849670

Tags Delayed Diagnosis, Electroencephalography, Female, Humans, Infant, Intensive Care, Neonatal, Monitoring, Physiologic, Near Drowning, Status Epilepticus

Prognostic value of continuous EEG monitoring during therapeutic hypothermia after cardiac arrest

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Abstract

INTRODUCTION Continuous EEG (cEEG) is increasingly used to monitor brain function in neuro-ICU patients. However, its value in patients with coma after cardiac arrest (CA), particularly in the setting of therapeutic hypothermia (TH), is only beginning to be elucidated. The aim of this study was to examine whether cEEG performed during TH may predict outcome.

METHODS From April 2009 to April 2010, we prospectively studied 34 consecutive comatose patients treated with TH after CA who were monitored with cEEG, initiated during hypothermia and maintained after rewarming. EEG background reactivity to painful stimulation was tested. We analyzed the association between cEEG findings and neurologic outcome, assessed at 2 months with the Glasgow-Pittsburgh Cerebral Performance Categories (CPC).

RESULTS Continuous EEG recording was started 12 ± 6 hours after CA and lasted 30 ± 11 hours. Nonreactive cEEG background (12 of 15 (75%) among nonsurvivors versus none of 19 (0) survivors; $P < 0.001$) and prolonged discontinuous "burst-suppression" activity (11 of 15 (73%) versus none of 19; $P < 0.001$) were significantly associated with mortality. EEG seizures with absent background reactivity also differed significantly (seven of 15 (47%) versus none of 12 (0); $P = 0.001$). In patients with nonreactive background or seizures/epileptiform discharges on cEEG, no improvement was seen after TH. Nonreactive cEEG background during TH had a positive predictive value of 100% (95% confidence interval (CI), 74 to 100%) and a false-positive rate of 0 (95% CI, 0 to 18%) for mortality. All survivors had cEEG background reactivity, and the majority of them (14 (74%) of 19) had a favorable outcome (CPC 1 or 2).

CONCLUSIONS Continuous EEG monitoring showing a nonreactive or discontinuous background during TH is strongly associated with unfavorable outcome in patients with coma after CA. These data warrant larger studies to confirm the value of continuous EEG monitoring in predicting prognosis after CA and TH.

Publication Critical Care (London, England)

Volume 14

Issue 5

Pages R173

Date 2010

Journal Abbr Crit Care

DOI 10.1186/cc9276

ISSN 1466-609X

URL http://www.ncbi.nlm.nih.gov/pubmed/20920227

Tags Adult, Aged, Aged, 80 and over, Electroencephalography, Female, Heart Arrest, Humans, Hypothermia, Induced, Male, Middle Aged, Monitoring, Physiologic, Prognosis, Prospective Studies, Treatment Outcome

How I treat patients with EEG patterns on the ictal-interictal continuum in the neuro ICU

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Abstract Refractory status epilepticus (RSE) is associated with a high risk of poor outcome and treated by most neurointensivists with continuous intravenous antiepileptic medications (cIV-AEDs). Continuous EEG monitoring has allowed us to unveil a number of epileptiform patterns of less certain significance. These have been labeled ictal to interictal continuum (IIC), many of which are associated with poor outcome. It is unclear to which extent individual patterns are epiphenomena or lead to additional brain injury. The treatment of these patterns is highly controversial and guidelines how to manage them are non existent. In this review of a challenging case, I will discuss a number of approaches to determine the ictal nature of the IIC in an effort to minimize neuronal injury from epileptiform brain activity on the one hand and from the treatment on the other hand. Ultimately it will be most important to replace the dichotomy of ictal versus non-ictal patterns by differentiating between harmful and non-harmful patterns.

Publication Neurocritical Care
Volume 11
Issue 3
Pages 437-444
Date Dec 2009
Journal Abbr Neurocrit Care
DOI 10.1007/s12028-009-9295-8
ISSN 1556-0961
URL http://www.ncbi.nlm.nih.gov/pubmed/19851892

Tags Aged, Anticonvulsants, Drug Resistance, Electroencephalography, Female, Humans, Intensive Care Units, Magnetic Resonance Imaging, Status Epilepticus, Tomography, Emission-Computed, Single-Photon

Analysis of routine EEG usage in a general adult ICU

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Author R P Murphy
Author S Connolly

Location

Abstract **BACKGROUND** Non-convulsive seizures and status epilepticus are common in brain-injured patients in intensive care units. Continuous electroencephalography (cEEG) monitoring is the most sensitive means of their detection. In centres where cEEG is unavailable, routine EEG is often utilized for diagnosis although its sensitivity is lower. AIMS To establish the rate of electrographic seizure detection in ICU using routine EEG. **METHODS** We identified all routine EEGs performed within a general adult ICU in Ireland over 3 years, and analyzed the clinical and EEG data. **RESULTS** Fifty-two patients underwent single or repeated EEG evaluation during the time period. Epileptiform abnormalities were evident in 15%, periodic abnormalities in 14%, and electrographic seizures in just one patient (2%) in their first or only routine EEG recording. **CONCLUSION** The rate of electrographic seizure detection by routine EEG in a general ICU is lower than anticipated. Earlier and more prolonged recordings are needed in this setting

Publication Irish Journal of Medical Science
Volume 178
Issue 3
Pages 263-266
Date Sep 2009
Journal Abbr Ir J Med Sci
DOI 10.1007/s11845-009-0317-5
ISSN 1863-4362
URL http://www.ncbi.nlm.nih.gov/pubmed/19296145

Tags Adult, Electroencephalography, Female, Humans, Intensive Care Units, Ireland, Male, Middle Aged, Retrospective Studies, Risk Factors, Status Epilepticus

Continuous EEG monitoring in the ICU - challenges and opportunities

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Abstract	Continuous EEG monitoring (CEEG) in the ICU is increasingly recognized as valuable means of monitoring cerebral function, otherwise inaccessible in the comatose patient. The principal applications are: monitoring for seizures and ischemia, guiding therapy for seizures and ischemia (especially vasospasm), adjusting levels of sedation for paralyzed or delirious patients, charting trends in brain function and prognosis. Continuous EEG monitoring is faced with numerous challenges: electrode failures (better electrodes are needed to replace standard EEG electrodes), documentation in the absence of a technologist, artifacts peculiar to ICU, prompt interpretation and review of large amounts of data, resource allocation and establishing the technology as being useful in improving outcomes and shortening ICU and hospital length of stay.

Publication	The Canadian Journal of Neurological Sciences. Le Journal Canadien Des Sciences Neurologiques
Issue	36 Suppl 2
Pages	S89-91
Date	Aug 2009
Journal Abbr	Can J Neurol Sci
ISSN	0317-1671
Short Title	Continuous EEG monitoring in the ICU
URL	http://www.ncbi.nlm.nih.gov/pubmed/19760913

Tags: Coma, Electroencephalography, Humans, Intensive Care Units, Monitoring, Physiologic, Seizures

Continuous electroencephalogram monitoring in the intensive care unit

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Abstract

PURPOSE: Because of recent technical advances, it is now possible to record and monitor the continuous digital electroencephalogram (EEG) of many critically ill patients simultaneously. Continuous EEG monitoring (cEEG) provides dynamic information about brain function that permits early detection of changes in neurologic status, which is especially useful when the clinical examination is limited. Nonconvulsive seizures are common in comatose critically ill patients and can have multiple negative effects on the injured brain. The majority of seizures in these patients cannot be detected without cEEG. cEEG monitoring is most commonly used to detect and guide treatment of nonconvulsive seizures, including after convulsive status epilepticus. In addition, cEEG is used to guide management of pharmacological coma for treatment of increased intracranial pressure. An emerging application for cEEG is to detect new or worsening brain ischemia in patients at high risk, especially those with subarachnoid hemorrhage. Improving quantitative EEG software is helping to make it feasible for cEEG (using full scalp coverage) to provide continuous information about changes in brain function in real time at the bedside and to alert clinicians to any acute brain event, including seizures, ischemia, increasing intracranial pressure, hemorrhage, and even systemic abnormalities affecting the brain, such as hypoxia, hypotension, acidosis, and others. Monitoring using only a few electrodes or using full scalp coverage, but without expert review of the raw EEG, must be done with extreme caution as false positives and false negatives are common. Intracranial EEG recording is being performed in a few centers to better detect seizures, ischemia, and peri-injury depolarizations, all of which may contribute to secondary injury. When cEEG is combined with individualized, physiologically driven decision making via multimodality brain monitoring, intensivists can identify when the brain is at risk for injury or when neuronal injury is already occurring and intervene before there is permanent damage.

The exact role and cost-effectiveness of cEEG at the current time remains unclear, but we believe it has significant potential to improve neurologic outcomes in a variety of settings.

Publication	Anesthesia and Analgesia
Volume	109
Issue	2
Pages	506-523
Date	Aug 2009
Journal Abbr	Anesth. Analg.
DOI	10.1213/ane.0b013e3181a9d8b5
ISSN	1526-7598
URL	http://www.ncbi.nlm.nih.gov/pubmed/19608827

Tags Brain, Brain Ischemia, Cost-Benefit Analysis, Critical Illness, Electroencephalography, Humans, Intensive Care, Intensive Care Units, Monitoring, Physiologic, Prognosis, Seizures, Status Epilepticus,

Development and implementation of a therapeutic hypothermia protocol

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Abstract Two randomized controlled trials published in 2002 demonstrated that mild hypothermia induced after resuscitation from cardiac arrest decreased mortality and improved neurologic outcomes. Although therapeutic hypothermia is relatively easy to implement, side effects and special nursing considerations are associated with this therapy. This article discusses the process of developing and implementing a therapeutic hypothermia protocol. Patients resuscitated after cardiac arrest are cooled to 32 degrees C-34 degrees C for 12-24 hrs. Discussion highlights include patient selection, physiologic effects of hypothermia, routes of induction, nursing implications, protocol development and implementation, and review of current literature related to this topic. An established hypothermia protocol, order set, and education program can be successfully implemented in any institution providing standardized care of post-cardiac arrest patients. (Note – Author says EEG critical but ICU RNs can not interpret results)

Publication

Volume

Issue

Pages

Date

Journal Abbr

DOI

ISSN

Short Title

URL

Tags

Continuous electroencephalography in the medical intensive care unit

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Abstract

OBJECTIVES To examine predictors and the prognostic value of electrographic seizures (ESZs) and periodic epileptiform discharges (PEDs) in medical intensive care unit (MICU) patients without a primary acute neurologic condition. DESIGN Retrospective study.
SETTING MICU in a university hospital. PATIENTS A total of 201 consecutive patients admitted to the MICU between July 2004 and January 2007 without known acute neurologic injury and who underwent continuous electroencephalography monitoring (cEEG) for investigation of possible seizures or changes in mental status. INTERVENTION None.
MEASUREMENTS AND MAIN RESULTS Median time from intensive care unit (ICU) admission to cEEG was 1 day (interquartile range 1-4). The majority of patients (60%) had sepsis as the primary admission diagnosis and 48% were comatose at the time of cEEG. Ten percent (n = 21) of patients had ESZs, 17% (n = 34) had PEDs, 5% (n = 10) had both, and 22% (n = 45) had either ESZs or PEDs. Seizures during cEEG were purely electrographic (no detectable clinical correlate) in the majority (67%) of patients. Patients with sepsis had a higher rate of ESZs or PEDs than those without sepsis (32% vs. 9%, $p < 0.001$). On multivariable analysis, sepsis at ICU admission was the only significant predictor of ESZs or PEDs (odds ratio 4.6, 95% confidence interval 1.9-12.7, $p = 0.002$). After controlling for age, coma, and organ dysfunction, the presence of ESZs or PEDs was associated with death or severe disability at hospital discharge (89% with ESZs or PEDs, vs. 39% if not; odds ratio 19.1, 95% confidence interval 6.3-74.6, $p < 0.001$).
CONCLUSION In this retrospective study of MICU patients monitored with cEEG, ESZs and PEDs were frequent, predominantly in patients with sepsis. Seizures were mainly nonconvulsive. Both seizures and periodic discharges were associated with poor outcome. Prospective studies are warranted to determine more precisely the frequency and clinical impact of nonconvulsive seizures and periodic discharges, particularly in septic patients.

Publication	Critical Care Medicine
Volume	37
Issue	6
Pages	2051-2056
Date	Jun 2009
Journal Abbr	Crit. Care Med.
DOI	10.1097/CCM.0b013e3181a00604
ISSN	1530-0293
URL	http://www.ncbi.nlm.nih.gov/pubmed/19384197

Tags Aged, Brain Diseases, Electroencephalography, Female, Humans, Intensive Care Units, Male, Middle Aged, Prognosis, Retrospective Studies, Seizures, Sepsis

How seizure detection by continuous electroencephalographic monitoring affects the prescribing of antiepileptic medications

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Abstract

OBJECTIVES To assess the effect of continuous electroencephalographic monitoring on the decision to treat seizures in the inpatient setting, particularly in the intensive care unit. DESIGN Retrospective cohort study.
SETTING: Medical and neuroscience intensive care units and neurological wards.
PATIENTS: Three hundred consecutive nonelective continuous electroencephalographic monitoring studies, performed on 287 individual inpatients over a 27-month period.
MAIN OUTCOME MEASURES: Epileptiform electroencephalographic abnormalities and changes in antiepileptic drug (AED) therapy based on the electroencephalographic findings.
RESULTS: The findings from the continuous electroencephalographic monitoring led to a change in AED prescribing in 52% of all studies with initiation of an AED therapy in 14%, modification of AED therapy in 33%, and discontinuation of AED therapy in 5% of all studies. Specifically, the detection of electrographic seizures led to a change in AED therapy in 28% of all studies.
CONCLUSIONS: The findings of continuous electroencephalographic monitoring resulted in a change in AED prescribing during or after half of the studies performed. Most AED changes were made as a result of the detection of electrographic seizures.

Publication	Archives of Neurology
Volume	66
Issue	6
Pages	723-728
Date	Jun 2009
Journal Abbr	Arch. Neurol
DOI	10.1001/archneurol.2009.100
ISSN	1538-3687
URL	http://www.ncbi.nlm.nih.gov/pubmed/19506131

Tags Adolescent, Adult, Aged, Aged, 80 and over, Anticonvulsants, Brain, Child, Child, Preschool, Cohort Studies, Decision Support Techniques, Drug Monitoring, Electroencephalography, Epilepsy, Evoked Potentials, Female, Humans, Infant, Infant, Newborn, Male, Middle Aged, Monitoring, Physiologic, Prescriptions, Retrospective Studies, Treatment Outcome, Young Adult,

Consensus on the use of neurophysiological tests in the intensive care unit (ICU): electroencephalogram (EEG), evoked potentials (EP), and electroneuromyography (ENMG)

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Abstract

STUDY AIM To provide a consensus of European leading authorities about the optimal use of clinical neurophysiological (CN) tests (electroencephalogram [EEG]; evoked potentials [EP]; electroneuromyography [ENMG]) in the intensive care unit (ICU) and, particularly, about the way to make these tests clinically useful for the management of individual patients.
METHODS: This study gathered together several European clinical neurophysiologists and neurointensivists whose leading contributions in the adult or paediatric ICU and in continuous neuromonitoring had been peer-acknowledged. It was based on both a literature review and each participant's own experience. Given the methodological impossibility to gather studies fulfilling criteria of evidence-based medicine, this article essentially relies on expert opinions that were gained after several rounds, in which each expert was invited to communicate his own contribution to all other experts. A complete consensus has been reached when submitting the manuscript.
RESULTS: What the group considered as the best classification systems for EEG and EP abnormalities in the ICU is first presented. CN tests are useful for diagnosis (epilepsy, brain death, and neuromuscular disorders), prognosis (anoxic ischemic encephalopathy, head trauma, and neurologic disturbances of metabolic and toxic origin), and follow-up, in the adult, paediatric, and neonatal ICU. Regarding prognosis, a clear distinction is made between these tests whose abnormalities are indicative of an ominous prognosis and those whose relative normalcy is indicative of a good prognosis. The prognostic significance of any test may vary as a function of coma etiology.
CONCLUSION CN provides quantitative functional assessment of the nervous system. It can be used in sedated or curarized patients. Therefore, it should play a major role in the individual assessment of ICU patients.

Publication	Neurophysiologie Clinique = Clinical Neurophysiology
Volume	39
Issue	2
Pages	71-83
Date	Apr 2009
Journal Abbr	Neurophysiol Clin
DOI	10.1016/j.neucli.2009.03.002
ISSN	1769-7131
Short Title	Consensus on the use of neurophysiological tests in the intensive care unit (ICU)
URL	http://www.ncbi.nlm.nih.gov/pubmed/19467437

Tags Adult, Brain Death, Brain Injuries, Child, Child, Preschool, Coma, Electrodiagnosis, Electroencephalography, Electromyography, Epilepsy, Evoked Potentials, Humans, Hypnotics and Sedatives, Hypoxia, Brain, Infant, Infant, Newborn, Infant, Premature, Infant, Premature, Diseases, Intensive Care, Intensive Care Units, Intensive Care Units, Neonatal, Monitoring, Physiologic, Neuromuscular Diseases, Practice Guidelines as Topic, Prognosis, Severity of Illness Index

Resuscitation and critical care of poor-grade subarachnoid hemorrhage

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Author	J Michael Schmidt	Neeraj Badjatia
Author	Robert M Starke	E Sander, Jr Connolly
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Abstract As outcomes have improved for patients with aneurysmal subarachnoid hemorrhage, most mortality and morbidity that occur today are the result of severe diffuse brain injury in poor-grade patients. The premise of this review is that aggressive emergency cardiopulmonary and neurological resuscitation, coupled with early aneurysm repair and advanced multimodality monitoring in a specialized neurocritical care unit, offers the best approach for achieving further improvements in subarachnoid hemorrhage outcomes. Emergency care should focus on control of elevated intracranial pressure, optimization of cerebral perfusion and oxygenation, and medical and surgical therapy to prevent rebleeding.

In the postoperative period, advanced monitoring techniques such as continuous electroencephalography, brain tissue oxygen monitoring, and microdialysis can detect harmful secondary insults, and may eventually be used as end points for goal-directed therapy, with the aim of creating an optimal physiological environment for the comatose injured brain. As part of this paradigm shift, it is essential that aggressive surgical and medical support be linked to compassionate end-of-life care. As neurosurgeons become confident that comfort care can be implemented in a straightforward fashion after a failed trial of early maximal intervention, the usual justification for withholding treatment (survival with neurological devastation) becomes less relevant, and lives may be saved as more patients recover beyond expectations.

Publication	Neurosurgery
Volume	64
Issue	3
Pages	397-410; discussion 410-411
Date	Mar 2009
Journal Abbr	Neurosurgery
DOI	10.1227/01.NEU.0000338946.42939.C7
ISSN	1524-4040
URL	http://www.ncbi.nlm.nih.gov/pubmed/19240601

Tags Brain Injuries, Cardiopulmonary Resuscitation, Critical Care, Humans, Subarachnoid Hemorrhage

Interobserver agreement in the interpretation of EEG patterns in critically ill adults

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Abstract

The significance of rhythmic and periodic EEG patterns in critically ill patients is unclear. A universal terminology is needed to facilitate study of these patterns, and consistent observer agreement should be demonstrated in its use. The authors evaluated inter- and intraobserver agreement using the standardized terminology (Hirsch et al., J Clin Neurophysiol 2005;22:128-135) recently proposed by the American Clinical Neurophysiology Society. Trained electroencephalographers viewed a series of 10-second EEG samples from critically ill adults (phase I), a set of >/=20-minute EEGs from the same patient cohort (phase II), and then reevaluated the first sample set (phase III). The readers used the proposed terminology to "score" each EEG. For each possible term, interobserver agreement (phases I and II) and intraobserver agreement (phase III) were calculated using pairwise kappa (kappa) values. Moderate agreement beyond chance was seen for the presence/absence of rhythmic or periodic patterns and for localization of these patterns. Agreement for other terms was slight to fair. Inter- and intraobserver agreement were consistently lower for optional terms than mandatory terms. Even when standardized terminology is used, the description of rhythmic and periodic EEG patterns varies significantly. Further refinement of the proposed terminology is required to improve inter- and intraobserver agreement.

Publication	Journal of Clinical Neurophysiology: Official Publication of the American Electroencephalographic Society
Volume	25
Issue	5
Pages	241-9
Date	Oct 2008
Journal Abbr	J Clin Neurophysiol
DOI	10.1097/WNP.0b013e318182ed67
ISSN	1537-1603
URL	http://www.ncbi.nlm.nih.gov/pubmed/18791475

Tags

Anticonvulsant medications in the pediatric emergency room and intensive care unit

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Abstract

Seizures are common in pediatric emergency care units, either as the main medical issue or in association with an additional neurological problem. Rapid treatment prolonged and repetitive seizures or status epilepticus is important. Multiple anti-convulsant medications are useful in this setting, and each has various indications and potential adverse effects that must be considered in regard to individual patients.

This review discusses new data regarding anticonvulsants that are useful in these settings, including fosphenytoin, valproic acid, levetiracetam, and topiramate. A status epilepticus treatment algorithm is suggested, incorporating changes from traditional algorithms based on these new data. Treatment issues specific to complex medical patients, including patients with brain tumors, renal dysfunction, hepatic dysfunction, transplant, congenital heart disease, and anticoagulation, are also discussed.

Publication	Pediatric Emergency Care
Volume	24
Issue	10
Pages	705-718; quiz 719-721
Date	Oct 2008
Journal Abbr	Pediatr Emerg Care
DOI	10.1097/PEC.0b013e318188fcac
ISSN	1535-1815
URL	http://www.ncbi.nlm.nih.gov/pubmed/19240677

Tags Adult, Anticonvulsants, Brain Hemorrhage, Traumatic, Brain Injuries, Child, Clinical Trials as Topic, Disease Management, Early Diagnosis, Electroencephalography, Emergencies, Emergency Service, Hospital, Heart Defects, Congenital, Humans, Intensive Care Units, Pediatric, Kidney Diseases, Liver Diseases, Neoplasms, Postoperative Complications, Seizures, Status Epilepticus, Transplantation

Detection and treatment of refractory status epilepticus in the intensive care unit

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Abstract

Status epilepticus (SE) is not rare in critically ill intensive care unit (ICU) patients, but its diagnosis is often delayed or missed, in part because it is mistaken for other causes of altered mental status. Even once diagnosed, SE in the ICU can be refractory to treatment. We sought to determine the causes, clinical features, and difficulties in diagnosis of SE in the ICU, and the effects of antiepileptic drugs (AEDs) on its course. We reviewed the course of ICU patients with both clinical and EEG evidence of SE, attempting to determine which patients are at risk for unsuspected SE, what was the typical delay in diagnosis, and whether AED treatment made a difference in their clinical courses. By clinical and EEG evidence, 91 ICU patients with SE were identified, all with abnormal mental status: 74 were comatose. Vascular disease (in 24) and anoxia (22) were the most common causes; most had multiple medical problems. Although 76 patients had clinically evident seizures earlier (and 56, clinical SE) only 20 were thought to be in SE at the time of the diagnostic EEG. There was a median delay of 48 hours from clinical deterioration until diagnosis in patients with earlier clinical seizures and 72 hours without seizures. Among the 68 nonanoxic patients treated with AEDs, 38 (56%) seemed to improve in alertness, including 25 who were comatose. Although patients who were stuporous or confused (vs. comatose) improved more often on AEDs, they were less often realized to be in SE before the EEG. Patients with earlier seizures were also more likely to improve, but no more likely to be diagnosed before the EEG. Patients who responded to AEDs were more likely to survive. ICU patients with altered mental status and EEG evidence of SE often have severe medical and surgical illnesses, refractory SE, and a high mortality. The delay to diagnosis is substantial, but a significant subset of patients improves on AEDs once SE is discovered. This diagnosis should be sought more often in ICU patients with abnormal mental status, especially after clinical seizures or SE without full recovery.

Publication	Journal of Clinical Neurophysiology: Official Publication of the American Electroencephalographic Society
Volume	25
Issue	4
Pages	181-186
Date	Aug 2008
Journal Abbr	J Clin Neurophysiol
DOI	10.1097/WNP.0b013e31817be70e
ISSN	1537-1603
URL	http://www.ncbi.nlm.nih.gov/pubmed/18677181

Tags Adult, Aged, Aged, 80 and over, Anticonvulsants, Boston, Electroencephalography, Female, Humans, Incidence, Intensive Care, Male, Middle Aged, Reproducibility of Results, Risk Assessment, Risk Factors, Sensitivity and Specificity, Status Epilepticus, Treatment Outcome

Seizures and status epilepticus in the critically ill

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Location	

Abstract	Seizures represent stereotypic electroencephalographic (EEG) and behavioral paroxysms as a consequence of electrical neurologic derangement. Seizures are usually described as focal or generalized motor convulsions; however, nonconvulsive seizures that occur in the absence of motor activity may escape clinical detection. Because of the admission diagnoses and dramatic physiologic and metabolic derangements common to critically ill patients, the entire spectrum of seizure disorders may be encountered in the ICU. Seizures in the ICU are attributable to primary neurologic pathology or secondary to critical illness and clinical management. For optimal treatment, early diagnosis of the seizure type and its cause is important to ensure appropriate therapy. Convulsive status epilepticus requires emergent treatment before irreversible brain injury and severe disturbances occur.

Publication	Critical Care Clinics
Volume	24
Issue	1
Pages	115-147, ix
Date	Jan 2008
Journal Abbr	Crit Care Clin
DOI	10.1016/j.ccc.2007.11.005
ISSN	0749-0704
URL	http://www.ncbi.nlm.nih.gov/pubmed/18241782

Tags Anticonvulsants, Critical Care, Electroencephalography, Humans, Intensive Care Units, Risk Factors, Seizures, Status Epilepticus

How I treat status epilepticus in the Neuro-ICU

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Abstract	Status epilepticus still remains a formidable adversary to neurointensivists. Although the majority of cases admitted to the Neuro-ICU are easily controlled with one or two antiepileptic drug defense lines, several cases become refractory and end up receiving general anesthetics for days or weeks with significant morbidity. Treatment algorithms have been published and should be followed, but in many cases they are inadequate because, especially in the distal branches of the treatment tree, are based on anecdotal data or small series of patients. In addition, a double-blind, randomized-controlled study in status has not been done for many years and solid data are lacking for the newer antiepileptics. Therefore, in the moderately to severely refractory cases, status treatment is based on personal previous experience and becomes an art more than a science. In this review of a difficult case, we discuss some fine details of the treatment provided and emphasize the multidisciplinary approach that should be followed including involvement of neurointensivists, epileptologists, and neurosurgeons.

Publication	Neurocritical Care
Volume	9
Issue	1
Pages	153-157
Date	2008
Journal Abbr	Neurocrit Care
DOI	10.1007/s12028-008-9052-4
ISSN	1541-6933
URL	http://www.ncbi.nlm.nih.gov/pubmed/18256795

Tags Algorithms, Anticonvulsants, Electroencephalography, Humans, Intensive Care, Magnetic Resonance Imaging, Male, Middle Aged, Neurology, Status Epilepticus,

Treatment strategies for refractory status epilepticus

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Abstract

PURPOSE: Status epilepticus is one of the most common emergencies in neurology, and every third patient does not respond to adequate first-line treatment. Refractory status epilepticus may be associated with increased morbidity and mortality, and new treatment options are urgently required. This review critically discusses recently published data regarding the role of 'new' antiepileptic drugs, the efficacy and safety of anesthetic agents, and the overall clinical outcome that is an integral part of treatment decisions.

RECET FINDINGS: In complex partial status epilepticus, levetiracetam may be administered after failure of first-line and/or second-line agents. Lacosamide may be an interesting new adjunct, but reliable data are pending. In the treatment of refractory generalized convulsive status epilepticus, propofol seems to be as efficient as barbiturates. The latter are associated with prolonged ventilation times due to redistribution kinetics, whereas the former bears the risk of propofol infusion syndrome if administered continuously. Even after prolonged treatment with anesthetics over weeks, survival with satisfactory functional outcome is possible.

SUMMARY: Unambiguous recommendations regarding treatment strategies for refractory status epilepticus are limited by a lack of reliable data. Therefore, randomized controlled trials or at least prospective observational studies based on strict protocols incorporating long-term outcome data are urgently required.

Publication Current Opinion in Critical Care

Volume 17

Issue

Pages 94–100

Date 2011

DOI 10.1097/MCC.0b013e328342fab5

URL http://www.med.unc.edu/neurology/neurocritical-care/docs/sz/Holtkamp

Tags Bispectral Index monitor, functional outcome, lacosamide, levetiracetam, propofol, infusion syndrome

Hypothermia for refractory status epilepticus

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Abstract

INTRODUCTION: Status epilepticus (SE) can be refractory to conventional anticonvulsants, requiring anesthetic doses of medications to suppress seizures. This approach carries significant morbidity, is associated with a high fatality rate, and may not always control SE. Hypothermia has been shown to suppress epileptiform activity experimentally, but has not previously been used as a primary modality to control SE in humans.
METHODS Four patients with SE refractory to benzodiazepine and/or barbiturate infusions were treated with hypothermia (target temperature: 31-35 degrees C) using an endovascular cooling system. All received continuous EEG monitoring, three were on midazolam infusions and one had recurrent seizures on weaning from pentobarbital.
RESULTS Therapeutic hypothermia was successful in aborting seizure activity in all four patients, allowing midazolam infusions to be discontinued; three achieved a burst-suppression pattern on EEG. After controlled rewarming, two patients remained seizure-free, and all four demonstrated a marked reduction in seizure frequency. Adverse events included shivering, coagulopathy without bleeding, and venous thromboembolism. Two death occurred, neither directly related to hypothermia; however, immunosuppression related to the use of barbiturates and hypothermia may have contributed to an episode of fatal sepsis in one patient.
CONCLUSIONS Hypothermia was able to suppress seizure activity in patients with SE refractory to traditional therapies with minimal morbidity. It appears promising as an alternative or an adjunct to anesthetic doses of other agents, but requires further study to better evaluate its safety and efficacy.

Publication	Neurocritical Care
Volume	9
Issue	2
Pages	189-197
Date	2008
Journal Abbr	Neurocrit Care
DOI	10.1007/s12028-008-9092-9
ISSN	1541-6933
URL	http://www.ncbi.nlm.nih.gov/pubmed/18415032

Tags Aged, Barbiturates, Benzodiazepines, Critical Care, Drug Resistance, Electroencephalography, Humans, Hypothermia, Induced, Male, Middle Aged, Monitoring, Physiologic, Status Epilepticus

Hypothermia in refractory status epilepticus

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2nd Innsbruck Hypothermia Symposium, Portoroz, Slovenia

Abstract Status epilepticus (SE) is a neurological emergency with potentially important mortality and morbidity. After refractoriness to general anesthetics, several pharmacological and nonpharmacological options have been described more or less anecdotally. In this context, and despite animal data supporting neuroprotective actions of brain hypothermia and showing its efficacy in SE models, hypothermia targeting a core temperature of about 33°C for at least 24 hours together with pharmacological sedation has been scarcely reported in adults and children. It seems that this approach rarely allows a sustained control of SE, as seizures tend to recur in normothermic conditions. Conversely, hypothermia has a high evidence level and is increasingly used in postanoxic encephalopathy, both in newborns and adults. Due to the thin available clinical evidence, prospective studies are needed to define the value of hypothermia in SE.

CONCLUSION: As there is a lack of clinical evidence, mild TH (32 to 36°C) may represent a therapeutic option for RSE, albeit on a patient by patient basis. Barbiturates should be avoided because of the risk of paralytic ileus (thus favoring midazolam or propofol), and mild hypothermia should be administered for 24 to 48 hours.

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Publication Critical Care.

Volume 16

Issue Supplemental 2

Pages A26

Date June 7, 2012

Journal Abbr Crit Care

DOI 10.1186/cc11284

URL http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3389486/

Tags

Nonconvulsive electrographic seizures after traumatic brain injury result in a delayed, prolonged increase in intracranial pressure and metabolic crisis

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Abstract

OBJECTIVE: To determine whether nonconvulsive electrographic post-traumatic seizures result in increases in intracranial pressure and microdialysis lactate/pyruvate ratio.
DESIGN: Prospective monitoring with retrospective data analysis. SETTING: Single center academic neurologic intensive care unit.
PATIENTS: Twenty moderate to severe traumatic brain injury patients (Glasgow Coma Score 3-13).
MEASUREMENTS AND MAIN RESULTS: Continuous electroencephalography and cerebral microdialysis were performed for 7 days after injury. Ten patients had seizures and were compared with a matched cohort of traumatic brain injury patients without seizures. The seizures were repetitive and constituted status epilepticus in seven of ten patients. Using a within-subject design, post-traumatic seizures resulted in episodic increases in intracranial pressure (22.4 +/- 7 vs. 12.8 +/- 4.3 mm Hg; $p < .001$) and an episodic increase in lactate/pyruvate ratio (49.4 +/- 16 vs. 23.8 +/- 7.6; $p < .001$) in the seizure group. Using a between-subjects comparison, the seizure group demonstrated a higher mean intracranial pressure (17.6 +/- 6.5 vs. 12.2 +/- 4.2 mm Hg; $p < .001$), a higher mean lactate/pyruvate ratio (38.6 +/- 18 vs. 27 +/- 9; $p < .001$) compared with nonseizure patients. The intracranial pressure and lactate/pyruvate ratio remained elevated beyond postinjury hour 100 in the seizure group but not the nonseizure group ($p < .02$).
CONCLUSION: Post-traumatic seizures result in episodic as well as long-lasting increases in intracranial pressure and microdialysis lactate/pyruvate ratio. These data suggest that post-traumatic seizures represent a therapeutic target for patients with traumatic brain injury..

Publication	Critical Care Medicine
Volume	35
Issue	12
Pages	2830-6
Date	Dec 2007
Journal Abbr	Crit Care Med
DOI	00903493
URL	http://www.ncbi.nlm.nih.gov/pubmed/18074483

Tags Case-Control Studies, Epilepsies, Partial, Epilepsy, Generalized, Epilepsy, Post-Traumatic, Humans, Intracranial Hypertension, Lactic Acid, Microdialysis, Middle Aged, Prospective Studies, Pyruvic Acid, Retrospective Studies, Status Epilepticus

Multimodal monitoring in the ICU: when could it be useful?

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Abstract	In the neurointensive care unit, neurologic monitoring is depended upon to signal the onset of neurologic decline. Many monitoring techniques such as intracranial pressure monitoring, cerebral perfusion pressure measurement, jugular venous oxygen saturation, transcranial Doppler ultrasound and continuous electroencephalogram are commonly practiced. Newer methods of monitoring include quantitative EEG, direct cerebral blood flow measurements, cerebral microdialysis, brain tissue oxygenation and cerebral near-infrared spectroscopy. When used in combination, as in multimodal monitoring, the goal is to overcome some of the disadvantages of each technique and to achieve a higher degree of accuracy in detecting secondary brain insults. However, such a large amount of data can be generated that such combinations have to be chosen carefully, or the monitoring data will not be able to be acted upon quickly enough to be of benefit to the patient.

Publication	Journal of the Neurological Sciences
Volume	261
Issue	1-2
Pages	10-15
Date	Oct 15, 2007
Journal Abbr	J. Neurol. Sci.
DOI	10.1016/j.jns.2007.04.027
ISSN	0022-510X
Short Title	Multimodal monitoring in the ICU
URL	http://www.ncbi.nlm.nih.gov/pubmed/17544449

Tags Brain Death, Humans, Intensive Care Units, Monitoring, Physiologic, Nervous System Diseases, Oximetry, Reproducibility of Results

Electrographic seizures and periodic discharges after intracerebral hemorrhage

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Author	M Schmidt	S A Mayer
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Abstract

OBJECTIVE To determine the frequency and significance of electrographic seizures and other EEG findings in patients with intracerebral hemorrhage (ICH).

METHODS We reviewed 102 consecutive patients with ICH who underwent continuous electroencephalographic monitoring (cEEG). Demographic, clinical, radiographic, and cEEG findings were recorded. Using multivariate logistic regression analysis, we determined factors associated with 1) electrographic seizures, 2) periodic epileptiform discharges (PEDs), and 3) poor outcome (death, vegetative or minimally conscious state) at hospital discharge.

RESULTS Seizures occurred in 31% (n = 32) of patients with ICH, prior to cEEG in 19 patients. Eighteen percent (n = 18) of patients had electrographic seizures; only one of these patients also had clinical seizures while on cEEG. After controlling for demographic and clinical predictors, only an increase in ICH volume of 30% or more between admission and 24-hour follow-up CT scan was associated with electrographic seizures (33% vs 15%; OR 9.5, 95% CI 1.7 to 53.8). PEDs were less frequently seen in those with hemorrhages located at least 1 mm from the cortex (8% vs 29%; OR 0.2, 95% CI 0.1 to 0.7). PEDs were independently associated with poor outcome (65% vs 17%; OR 7.6, 95% CI 2.1 to 27.3). In patients with electrographic seizures, the first seizure was detected within the first hour of cEEG monitoring in 56% and within 48 hours in 94%.

CONCLUSIONS Seizures occurred in one third of patients with intracerebral hemorrhage (ICH) and over half were purely electrographic. Electrographic seizures were associated with expanding hemorrhages, and periodic discharges with cortical ICH and poor outcome. Further research is needed to determine if treating or preventing seizures or PEDs might lead to improved outcome after ICH.

Publication	Neurology
Volume	69
Issue	13
Pages	1356-1365
Date	Sep 25, 2007
Journal Abbr	Neurology
DOI	10.1212/01.wnl.0000281664.02615.6c
ISSN	1526-632X
URL	http://www.ncbi.nlm.nih.gov/pubmed/17893296

Tags Aged, Brain, Cerebral Hemorrhage, Cerebrovascular Circulation, Electroencephalography, Female, Humans, Intensive Care Units, Intracranial Hypertension, Male, Middle Aged, Monitoring, Physiologic, Predictive Value of Tests, Recurrence, Retrospective Studies, Seizures, Status Epilepticus, Tomography, X-Ray Computed

ICU EEG monitoring: nonconvulsive seizures, nomenclature, and pathophysiology

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Abstract

PURPOSES

METHODS

RESULTS

CONCLUSIONS.

Publication Clinical Neurophysiology: Official Journal of the International Federation of Clinical

Volume 118

Issue 8

Pages 1653-1654

Date Aug 2007

Journal Abbr Clin Neurophysiol

DOI 10.1016/j.clinph.2007.01.026

ISSN 1388-2457

Short Title ICU EEG monitoring

URL http://www.ncbi.nlm.nih.gov/pubmed/17573237

Tags Electroencephalography, Humans, Intensive Care Units, Monitoring, Physiologic, Seizures, Terminology as Topic

Nonconvulsive seizures: developing a rational approach to the diagnosis and management in the critically ill population

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Abstract Originally described in patients with chronic epilepsy, nonconvulsive seizures (NCSs) are being recognized with increasing frequency, both in ambulatory patients with cognitive change, and even more so in the critically ill. In fact, the majority of seizures that occur in the critically ill are nonconvulsive and can only be diagnosed with EEG monitoring. The semiology of NCSs and the associated EEG findings are quite variable. There are a number of periodic, rhythmic or stimulation-related EEG patterns in the critically ill of unclear significance and even less clear treatment implications. The field struggles to develop useful diagnostic criteria for NCSs, to standardize nomenclature for the numerous equivocal patterns, and to devise studies that will help determine which patterns should be treated and how aggressively. This review surveys the evidence for and against NCSs causing neuronal injury, and attempts to develop a rational approach to the diagnosis and management of these seizures, particularly in the Encephalopathic population

Publication Clinical neurophysiology : official journal of the International Federation of Clinical Neurophysiology

Volume 118

Issue 8

Pages 1660-70

Date Aug 2007

Journal Abbr Clin Neurophysiol

DOI 13882457

Short Title Nonconvulsive seizures

URL http://www.ccmpitt.com/ebm/neuro_icu/Jirsch%20J,%20et%20al.%20%20Nonconvulsive%20seizures.pdf

Tags Animals, Brain Diseases, Critical Illness, Humans, Intensive Care Units, Seizures, Status Epilepticus

Multimodality monitoring in neurocritical care

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Abstract Multimodality monitoring of cerebral physiology encompasses the application of different monitoring techniques and integration of several measured physiologic and biochemical variables into assessment of brain metabolism, structure, perfusion, and oxygenation status. Novel monitoring techniques include transcranial Doppler ultrasonography, neuroimaging, intracranial pressure, cerebral perfusion, and cerebral blood flow monitors, brain tissue oxygen tension monitoring, microdialysis, evoked potentials, and continuous electroencephalogram. Multimodality monitoring enables immediate detection and prevention of acute neurologic injury as well as appropriate intervention based on patients' individual disease states in the neurocritical care unit. Real-time analysis of cerebral physiologic, metabolic, and cardiovascular parameters simultaneously has broadened knowledge about complex brain pathophysiology and cerebral hemodynamics. Integration of this information allows for more precise diagnosis and optimization of management of patients with brain injury.

Publication	Critical Care Clinics
Volume	23
Issue	3
Pages	507-538
Date	Jul 2007
Journal Abbr	Crit Care Clin
DOI	10.1016/j.ccc.2007.06.002
ISSN	0749-0704
URL	http://www.ncbi.nlm.nih.gov/pubmed/17900483

Tags Central Nervous System Diseases, Cerebrum, Combined Modality Therapy, Critical Care, Decision Support Systems, Clinical, Diagnostic Imaging, Electroencephalography, Humans, Intensive Care Units, Monitoring, Physiologic, Neurologic Examination, Oximetry Central Nervous System Diseases, Cerebrum, Combined Modality Therapy, Critical Care, Decision Support Systems, Clinical, Diagnostic Imaging, Electroencephalography, Humans, Intensive Care Units, Monitoring, Physiologic, Neurologic Examination, Oximetry

Rhythmic artifact of physiotherapy in intensive care unit EEG recordings

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Abstract	Intensive care unit EEG recordings are often contaminated by artifacts that are unseen elsewhere and are usually not documented. One is the rhythmic artifact of physiotherapy (RAP), which can follow the frequency of chest percussion or vibration with either fundamental or harmonic sinusoidal wave forms, affecting single or multiple channels. The occipital electrodes are the most commonly affected, but others can be involved separately or in combination. RAP can easily be mistaken for cerebrally originating rhythms, including seizures. RAP is most easily detected by examining the ECG channel, which usually captures the artifact, but video EEG provides another means, at least for chest percussion.

Publication	Journal of Clinical Neurophysiology: Official Publication of the American Electroencephalographic Society
Volume	24
Issue	3
Pages	252-256
Date	Jun 2007
Journal Abbr	J Clin Neurophysiol
DOI	10.1097/WNP.0b013e318053e6af
ISSN	0736-0258
URL	http://www.ncbi.nlm.nih.gov/pubmed/17545828

Tags Adult, Artifacts, Electroencephalography, Humans, Intensive Care Units, Physical Therapy Modalities, Spectrum Analysis

Neurocritical care: a distinct discipline?

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Abstract

PURPOSE OF REVIEW We sought to review the evidence supporting neurocritical care as a distinct specialty of medicine.

RECENT FINDINGS Over the past 20 years, neuro-intensive care units have evolved from neurosurgical units focused primarily on postoperative monitoring to units that provide comprehensive medical and specialized neurological support for patients with life-threatening neurological diseases. In addition to standard interventions, areas of expertise unique to neurocritical care include management of intracranial pressure, hemodynamic augmentation to improve cerebral blood flow, therapeutic hypothermia, and advanced neuromonitoring (i.e. continuous electroencephalography, brain-tissue oxygen, and microdialysis). Neurointensivists defragment care by focusing on the interplay between the brain and other systems, and by integrating all aspects of neurological and medical management into a single care plan. Outcomes research has established that victims of traumatic brain injury and hemorrhagic stroke experience reduced mortality, better functional outcomes, and reduced length of stay when cared for by neurointensivists in a dedicated neuro-intensive care unit. In the US a national system for accrediting training programs and certifying intensivists with special qualifications in neurocritical care is currently being established by the United Council of Neurologic Subspecialties.

SUMMARY Neurocritical care is one of the newest subspecialties of medicine and is at the forefront of bringing effective new therapies to patients with life-threatening neurological diseases.

Publication	Current Opinion in Critical Care
Volume	13
Issue	2
Pages	115-121
Date	Apr 2007
Journal Abbr	Curr Opin Crit Care
DOI	10.1097/MCC.0b013e32808255c6
ISSN	1070-5295
Short Title	Neurocritical care
URL	http://www.ncbi.nlm.nih.gov/pubmed/17327730

Tags Brain Injuries, Brain Ischemia, Critical Care, Humans, Intracranial Hemorrhages, Length of Stay, Nervous System Diseases, Treatment Outcome

Development of a pediatric neurocritical care service.

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Abstract

To describe the development of a Pediatric Neurocritical Care (PNCCM) service; define the patient population that requires the service and describe important outcome parameters.

METHODS:

An analysis of prospectively collected data from a database was performed in a tertiary-care, academic children's hospital. Critically ill children who received a PNCCM consult between April, 2006 and May 2007 were included in the analysis. Demographic data (including age, Pediatric Intensive Care Unit (PICU) admission diagnosis, reason for PNCCM consult, timing of consult, and medical/neurological co-morbidities), outcome (PICU mortality and hospital length of stay) and result of consults (resources utilized, new consults or differential diagnoses suggested) were collected.

RESULTS:

Over a 14-month period, 373 PNCCM consults were obtained (total PICU admissions 1,423) at an average of 3.6 days +/- 0.5 after PICU admission. PNCCM consults had a higher mortality than overall PICU population (11.0% vs. 5.2%; $P < 0.001$) and longer hospital length of stay (18.5 days +/- 1.4 vs. 6.7 days +/- 1.9). The majority (64.1%) of PNCCM consults were admitted to the PICU with neurological diagnoses (status epilepticus was the most common). A significant percentage (35.9%) had critical medical conditions at presentation and the disorders of our PNCCM consults were very different from those observed in adult NCCM services. PNCCM consults suggested an additional and differential diagnosis in 148 children and an additional 105 consults from other services. More than 787 procedures or diagnostic neurological tests were performed in this cohort of children in the PICU.

CONCLUSION:

A PNCCM team was asked to assist in managing almost one-quarter of the total patient census in an urban, tertiary-care, teaching hospital. The number of consults is comparable to those observed in early studies in adult NCCM team development but the admission diagnoses are distinct. The PNCCM consulted on children with high mortality rates. Future studies will be needed to determine if the presence of a PNCCM can result in improved patient outcomes.

Publication Neurocritical Care.

Volume 10

Issue 1

Pages 4-10

Date 2009

Journal Abbr Neurocrit Care

DOI 10.1007/s12028-008-9061-3.

URL http://www.ncbi.nlm.nih.gov/pubmed/18256793

Frequency and predictors of nonconvulsive seizures during continuous electroencephalographic monitoring in critically ill children

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Abstract

OBJECTIVE To determine the incidence, predictors, and timing of nonconvulsive seizures (NCSz) during continuous electroencephalographic monitoring (cEEG) in critically ill children.

METHODS We identified critically ill children who underwent cEEG during a 4-year period. Multivariate logistic regression analysis was performed to determine variables associated with NCSz.

RESULTS Among 117 monitored children, 44% had seizures on cEEG and 39% had NCSz. The majority of patients with seizures (75%) had purely NCSz, and 23% of patients had status epilepticus, which was purely nonconvulsive in 89% of cases. Seizures occurred immediately on cEEG initiation in 15%, within 1 hour in 50%, and within 24 hours in 80%. Those with clinical seizures prior to cEEG were more likely to have NCSz on cEEG (83%) than those without prior seizures (17%). On multivariate analysis, NCSz were associated with periodic lateralized epileptiform discharges and absence of background reactivity.

CONCLUSIONS Seizures, the majority being NCSz, are common during cEEG in critically ill children (seen in 44% of patients). Half are detected in the first hour of recording, whereas 20% are not detected until after more than 24 hours of recording. Nonconvulsive seizures are associated with periodic lateralized epileptiform discharges and absence of reactivity on cEEG. This study confirms the importance of prolonged cEEG for critically ill children as a means to detect NCSz.

Publication	Archives of Neurology
Volume	63
Issue	12
Pages	1750-1755
Date	Dec 2006
Journal Abbr	Arch. Neurol.
DOI	10.1001/archneur.63.12.1750
ISSN	0003-9942
URL	http://www.ncbi.nlm.nih.gov/pubmed/17172615

Tags Adolescent, Child, Child, Preschool, Cohort Studies, Critical Illness, Data Collection, Electroencephalography, Female, Humans, Infant, Male, Seizures, Status Epilepticus, Treatment Outcome

Continuous EEG monitoring in the ICU

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Abstract	**PURPOSES** **METHODS** **RESULTS** **CONCLUSIONS**.

Publication	Acta Neurologica Scandinavica
Volume	114
Issue	1
Pages	67-68
Date	Jul 2006
Journal Abbr	Acta Neurol. Scand.
DOI	10.1111/j.1600-0404.2006.00651.x
ISSN	0001-6314
URL	http://www.ncbi.nlm.nih.gov/pubmed/16774631

Tags:

Brain Injuries, Cerebral Cortex, Cost-Benefit Analysis, Electroencephalography, Epilepsy, Humans, Intensive Care Units, Length of Stay, Monitoring, Physiologic, Patient Care Team, Predictive Value of Tests, Status Epilepticus,

EEG monitoring in the intensive care unit

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Location	Johns Hopkins University School of Medicine, Epilepsy and Electrophysiology Monitoring Unit, Baltimore, Maryland 21225, USA.

Abstract	EEG recording in the intensive care setting presents a number of technical challenges. It is essential to differentiate artifact from pathophysiologic EEG changes that would suggest encephalopathy, epileptiform activity, or seizures. There are particular patterns typical of deepening encephalopathy, as well as, coma patterns that have diagnostic and prognostic significance (e.g., spindle coma, alpha coma, burst suppression activity, and triphasic waves). Epileptiform patterns, including periodic lateralized epileptiform discharges (PLEDs), bilateral independent periodic lateralized epileptiform discharges (BIPLEDs), and generalized periodic epileptiform discharges (GPEDs), present particular challenges as there is a gray-zone between interictal patterns and the evolving (usually faster) patterns of nonconvulsive seizures. Accurate use of EEG in the intensive care unit requires optimal EEG technical expertise in performing the study, and appropriate interpretation by a trained electrophysiologist.

Publication	American Journal of Electroneurodiagnostic Technology
Volume	46
Issue	2
Pages	81-97
Date	Jun 2006
Journal Abbr	Am J Electroneurodiagnostic Technol
ISSN	1086-508X
URL	http://www.ncbi.nlm.nih.gov/pubmed/16848306

Tags Coma, Electroencephalography, Epilepsy, Humans, Intensive Care, Intensive Care Units, Monitoring, Physiologic, Practice Guidelines as Topic, Prognosis, Risk Assessment, Risk Factors, United States

The implications of cerebral ischemia and metabolic dysfunction for treatment strategies in neurointensive care

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Abstract

PURPOSE OF REVIEW This review outlines recent observations made in a clinical setting that document the extent and degree of cerebral ischemia and metabolic dysfunction after acute brain injury. The intent is to guide clinicians in considering how best to monitor and treat brain metabolism in the intensive care unit.

RECENT FINDINGS Recent findings have documented that following brain injury there is a heterogeneous distribution of disturbed metabolism with some areas of the brain rendered severely oligemic or ischemic while other areas are less affected. Areas that are not truly ischemic, however, still appear to be at risk of excitotoxic injury. Various methods of monitoring the brain are compared and discussed, including positron emission tomography, brain parenchymal oxygenation monitoring, brain microdialysis, and continuous electroencephalography; important caveats are also presented. These methods are complementary and provide information about oxygen utilization and other aspects of brain metabolism. Integration of these methods into a practical clinical protocol is discussed.

SUMMARY The intensive care of acute brain injury has entered a new era in which monitoring of brain metabolism will permit targeted therapy and may possibly minimize iatrogenic adverse effects by making better use of our powerful therapies.

Publication Current Opinion in Critical Care

Volume 12

Issue 2

Pages 119-123

Date Apr 2006

Journal Abbr Curr Opin Crit Care

DOI 10.1097/01.ccx.0000216577.57180.bd

ISSN 1070-5295

URL http://www.ncbi.nlm.nih.gov/pubmed/16543786

Tags Brain Injuries, Brain Ischemia, Critical Care, Humans, Injury Severity Score, Microdialysis, Positron-Emission Tomography,

Ellen R. Grass Lecture: Rapid EEG analysis for intensive care decisions in status epilepticus

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Abstract

Nonconvulsive status epilepticus in intensive care units (ICUs) is common and increases the risk of death. Nonconvulsive status epilepticus treatment delays are associated with poor patient outcomes. Continuous EEG or EEG-video monitoring is used in ICU settings to diagnose subtle seizures and nonconvulsive status epilepticus among at-risk populations including patients with closed head injuries and altered consciousness, stroke, subarachnoid hemorrhage, neonates at-risk for sepsis or hypoxic-ischemic encephalopathy, and children who have undergone surgery for congenital heart disease. However expert EEG interpretation, currently required for accurate diagnosis, often lags behind the real-time recordings by hours or even longer. At most hospitals the numbers of at-risk patients in intensive care units far exceeds the capacity of the available EEG equipment and personnel to perform and interpret EEGs. Seizure-detection software, compressed EEG spectral arrays, and near real-time remote EEG interpretation have brought us closer to the goal of real-time analysis of EEG for intensive care decisions, but even at major tertiary referral centers the vast majority of at-risk ICU patients do not undergo EEG monitoring. Additional technological advances, innovative use of EEG technologists and ICU personnel, and clinical trials of new EEG monitoring technology and associated clinical outcomes are needed to achieve the goal of optimal use of EEG data for intensive care decisions.

Publication	American Journal of Electroneurodiagnostic Technology
Volume	46
Issue	1
Pages	4-17
Date	Mar 2006
Journal Abbr	Am J Electroneurodiagnostic Technol
DOI	1086-508X
ISSN	Ellen R. Grass Lecture
URL	http://www.ncbi.nlm.nih.gov/pubmed/16605169

Tags Decision Support Systems, Clinical, Diagnosis, Computer-Assisted, Electroencephalography, Humans, Intensive Care, Monitoring, Physiologic, Risk Assessment, Risk Factors, Status Epilepticus

Title

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Location	
Abstract	**PURPOSES** **METHODS** **RESULTS** **CONCLUSIONS.**
Publication	
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Abstract	**PURPOSES** **METHODS** **RESULTS** **CONCLUSIONS.**
Publication	
Volume	
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Journal Abbr	
DOI	
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Tags