seizures in the critically ill [created by Paul Young 28/11/07]

general

- seizures complicate about 3% of adult intensive care unit patients admitted with non-neurological conditions
- a seizure often indicates a CNS complication has arisen
- since epilepsy affects 2% of the population, patients with epilepsy are admitted to the ICU for other reasons
- status epilepticus refers to prolonged seizure episodes
- definitions used in studies of status epilepticus have varied substantially; however, 30 minutes of continuous seizure activity or repeated seizure activity without recovery
- the diagnosis of seizures in critically ill patients is complicated by the fact patients are already receiving sedation and may be paralysed; tachycardia, tachypnoea and hypertension are signs of seizure that are often misinterpreted as evidence of inadequate sedation

aetiology

Causes of status epilepticus represent an imperfect division into 3 groups:
1. 1/3rd have an exacerbation of a known seizure disorder
2. 1/3rd are presenting with a seizure disorder for the first time
3. 1/3rd have a structural, toxic or metabolic cause:
- stroke (remote or acute)
- hypoxic injury
- tumour
- trauma
- subarachnoid
- toxicological aetiologies (cocaine, theophylline, isoniazid, alcohol withdrawal)
- electrolyte abnormalities (hyponatraemia, hypernatraemia, hypercalcaemia, hepatic encephalopathy)
- infectious aetiology (meningitis, brain abscess, encephalitis)
- cavernous sinus thrombosis
- seizures in late pregnancy or post partum may represent eclampsia

pathophysiology

CNS
- increased cellular activity of status epilepticus elevates demand for oxygen and glucose and cerebral blood flow initially increases
- after approximately 20 minutes energy supplies are exhausted and local catabolism occurs in an effort to preserve the internal milieu; this is the major cause of brain damage in status epilepticus

Systemic
(i) excess secretion of adrenaline and cortisol causing systemic and pulmonary pressures to rise at seizure onset and also cause hyperglycaemia
(ii) muscular work increases blood lactate
(iii) both airway obstruction and abnormal diaphragm contractions impair respiration
(iv) muscular work accelerates heat production raising core body temperature
(v) combined acidoses frequently produce a pH of <6.9 & severe acidosis contributes to hyperkalaemia which in addition to its deleterious effects on cardiac physiology helps propagate seizure activity
(vi) patients often aspirate producing chemical pneumonitis or bacterial pneumonia
(vii) rhabdomyolysis is common & may lead to renal failure
(viii) compression fractures, joint dislocations and tendon avulsion are other complications
(ix) after approximately 30 minutes of continuous convulsions, motor activity may diminish while electrographic seizures persist. Hypotension and hyperthermia ensue and gluconeogenesis may fail leading to hypoglycaemia

differential diagnosis

asterixis:
- brief asynchronous loss of tone at the wrist or hip joints seen in the setting of hepatic dysfunction

myoclonus:
- controversy exists as to whether post anoxic myoclonus is an epileptiform disorder

brain injured patients:
- may exhibit paroxysmal episodes of sympathetic hyperactivity and associated rigidity or decerebrate posturing

tetanus:
- differentiated by the fact that patients are awake during their spasms and flex rather than extend their arms as seizure patients do

psychiatric disturbance:
- occasionally resembles complex partial seizures

clinical features

primary generalised convulsive status epilepticus
- begins as tonic extension of the trunk and extremities without preceding focal activity; no aura is reported and loss of consciousness is immediate
- after several seconds of tonic extension, the extremities start to vibrate and clonic rhythm extension of the extremities quickly follows
- the patient may then repeat the cycle of tonus followed by clonic movements or may intermittent bursts of clonus without recovery

secondary generalised status epilepticus:
- begins with a partial seizure and progresses to a generalised convulsion
- the presence of initial focal seizures implies a structural lesion

non-convulsive status following generalised convulsive status epilepticus:
- occurs when a patient experiencing a seizure is treated with an anticonvulsant which leads to termination of motor activity of a seizure but persistence of the electrochemical seizure
- patients who do not start to wake 20 minutes after treatment of status epilepticus should be assumed to have entered non convulsive status epilepticus
- careful observation of a patient with suspected 'non-convulsive status' in this circumstance may reveal slight clonic activity
- non-convulsive staqtus epilepticus demands emergency treatment guided by continuous EEG monitoring to prevent further cerebral damage since there are no clinical criteria to indicate whether therapy is effective

- features suggestive of pseudoseizure include lack of stereotyped seizures, lack of sustained convulsive activity, clonic movements that have a different rate on each side or vary in rate, poor response to treatment, abolition of motor response with reassurance or suggestion, gaze aversion or resistance to examination, normal tendon reflexes and plantar responses, lack of metabolic consequences after prolonged seizure

diagnostic approach

- observation is the most important activity when a patient has a single seizure as this is the time to collect evidence of partial onset to implicated structural brain disease; the post-ictal examination may identify language, motor, sensory or reflex abnormalities that are evidence of focal pathology
- drugs are a major cause of ICU seizures with causative agents including imipenem, fluoroquinolones & theophylline, hyposedative withdrawal; recreational drugs including cocaine, methamphetamine and alcohol
- non ketotic hyperglycaemia an hyponatraemia can both precipitate seizures
- hypocalcaemia rarely causes seizures beyond the neonatal period and hypomagnesemia even if present is unlikely to be the cause
- Imaging of the brain should be performed on patients with new seizures in the ICU as vascular, neoplastic or infectious explanations are common in the ICU population
- LP may be required
- EEG is a vital diagnostic tool. Partial seizures show EEG abnormalities that begin in the area of the cortex that produces seizures while primary generalised seizures appear to start over the entire cortex simultaneously
- indications for continuous EEG monitoring include refractory status epilepticus to aid titration of anticonvulsants and to ensure suppression of seizure activity, patients receiving neuromuscular blockade, patients who continue to have poor conscious state after apparent cessation of seizures, suspected non-convulsive status epilepticus in a patient with altered conscious state

classification of status epilepticus

I. Generalised seizures
A. Generalised convulsive status epilepticus
1. primary generalised status epilepticus
a. tonic clonic status epilepticus
b. myoclonic status epilepticus
c. clonic-tonic-clonic status epilepticus
2. Secondary generalised status epilepticus
a. partial seizure with secondary generalisation
b. tonic status epilepticus
B. Non convulsive status epilepticus
1. absence status epilepticus (petit mal status)
2. atypical absence status epilepticus
3. atonic status epilepticus
4. nonconvulsive status epilepticus as a consequence of partially treated generalised convulsive status epilepticus
II. Partial status epilepticus
A. Simple partial status epilepticus
1. typical
2. epilepsia partialis continua
B. Complex partial status epilepticus
III. Neonatal status epilepticus

NB: 'non convulsive status may encompass partially treated generalised seizures, complex partial status epilepticus & absence status epilepticus

treatment of isolated seizures

general:
- making a decision about administering anticonsulvants to an ICU patient requires consideration of a provisional cause, estimation of the likelihood of recurrence and recognition of the utility and limitation of anticonvulsants

examples:
(i) alcohol withdrawal - can be treated with benzodiazepines, phenytoin is ineffective, long-term anticonvulsants are not required
(ii) metabolic disturbances - can be treated temporarily by benzodiazepines while the disturbance is corrected phenytoin is ineffective in this setting
(iii) CNS disease: the ICU patient with CNS disease who has even one seizure should be started on chronic anticonvulsants. There are some neurologists who believe that this treatment after the first unprovoked seizure may prevent subsequent epilepsy althought there is considerable debate about this
(iv) isoniaizid toxicity: pyridoxine is the drug of choice and specific antidote for isoniazid toxicity
(v) eclampsia: magnesium sulphate (initial dose of 4-6g over 15-20 minutes is the treatment of choice for eclampsia; if convulsion occurs after initial bolus an additional 2gm over 3-5 minutes may be administered)

treatment of status epilepticus

- generalised convulsive status epilepticus, non-convulsive status epilepticus and complex partial status epilepticus are medical emergencies. In each case, one must act quickly to prevent additional cerebral damage
- patients with simple partial status are less risk for widespread cerebral damage

I. establish an airway, provide oxygen and ensure ventilation. If a neuromuscular junction blockade is required for intubation use a short-acting agent such as suxamethonium or vecuronium
II. determine the blood pressure and correct hypotension; hypertension should not be treated until status epilepticus has been controlled ans treatment usually corrects it and many agents used to treat it cause hypotension
III. consider thiamine and dextrose
IV. terminate status epilepticus being cognisant of the potential of drugs to eliminate visible convulsant movements while leaving the patient in non-convulsive status. Patients who do not respond to external stimuli after 15 minutes should be considered to be in non-convulsive status and should undergo emergent EEG
A. Give lorazepam, 0.1mg/kg at a rate of 0.04mg/kg/min up to 10mg OR clonazepam 0.01-0.02mg/kg iv up to 4mg. If iv access is not present midazolam can be given via the IM, buccal or sublingual route (IM midazolam is rapidly absorbed & buccal and sublingual midazolam have similar efficacy to rectal diazepam)
B. If status epilepticus persists, give phenytoin 20mg/kg (an additional 5mg/kg may be given)
C. If status epilepticus persists, administer midazolam 0.2mg/kg as a bolus, followed by an infusion of 0.1-2.0mg/kg/hr to achieve seizure control (as determined by EEG monitoring). A patient reaching this stage requires intubation if it has not already been performed and should be treated in an intensive care unit
D. If status epilepticus persists administer propofol as a continuous infusion to control seizures as determined by EEG monitoring or administer phenobarbital at 12mg/kg at a rate of 0.2-0.4mg/kg/min as tolerated followed by an infusion of 0.25-2.0mg/kg/hr as determined by EEG monitoring (an isoelectric EEG may be required in some cases)

treat complications:
I. rhabdomyolysis:
- should be treated with vigorous saline diuresis to prevent acute renal failure; urinary alkalinisation may be useful
- if control of seizures takes longer than usual because neuromuscular blockade under EEG monitoring may be considered
II. hyperthermia:
- usually terminates after status epilepticus remits but cooling may occasionally be required
III. cerebal oedema:
- not well studied but may be present due to the underlying condition that causes the seizure
- oedema due to status epilepticus itself is vasogenic in origin and thus steroids may be useful