

## Children and Infants with Seizures - Acute Management

**Document Number** PD2009\_065

**Publication date** 16-Oct-2009

**Functional Sub group** Clinical/ Patient Services - Baby and child  
Clinical/ Patient Services - Medical Treatment

**Summary** Basic Clinical Practice Guidelines for the treatment of infants and children with seizures.

**Replaces Doc. No.** Children and Infants with Seizures - Acute Management [PD2006\_023]

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**Applies to** Area Health Services/Chief Executive Governed Statutory Health Corporation, Board Governed Statutory Health Corporations, Affiliated Health Organisations - Non Declared, Affiliated Health Organisations - Declared, Community Health Centres, NSW Ambulance Service, Public Hospitals

**Audience** Emergency Departments, Paediatric Units

**Distributed to** Public Health System, Divisions of General Practice, Government Medical Officers, NSW Ambulance Service, NSW Department of Health, Private Hospitals and Day Procedure Centres, Tertiary Education Institutes

**Review date** 16-Oct-2014

**Policy Manual** Patient Matters

**File No.** 07/9630

**Status** Active

### Director-General

This Policy Directive may be varied, withdrawn or replaced at any time. Compliance with this directive is **mandatory** for NSW Health and is a condition of subsidy for public health organisations.

## INFANTS AND CHILDREN: ACUTE MANAGEMENT OF SEIZURES

### PURPOSE

The *infants and children: acute management of seizures* clinical practice guideline (attached) has been developed to provide direction to clinicians and is aimed at achieving the best possible paediatric care in all parts of the state.

The clinical practice guideline was prepared for the NSW Department of Health by an expert clinical reference group under the auspice of the state wide Paediatric Clinical Practice Guideline Steering Group.

### MANDATORY REQUIREMENTS

This policy applies to all facilities where paediatric patients are managed. It requires all Health Services to have local guidelines/protocols based on the attached clinical practice guideline in place in all hospitals and facilities likely to be required to assess or manage children with seizures.

The clinical practice guideline reflects what is currently regarded as a safe and appropriate approach to the acute management of seizures in infants and children. However, as in any clinical situation there may be factors which cannot be covered by a single set of guidelines. This document should be used as a guide, rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. **It does not replace the need for the application of clinical judgement to each individual presentation.**

### IMPLEMENTATION

Chief Executives must ensure:

- Local protocols are developed based on the *infants and children: acute management of seizures* clinical practice guideline.
- Local protocols are in place in all hospitals and facilities likely to be required to assess or manage paediatric patients with seizures.
- Ensure that all staff treating paediatric patients are educated in the use of the locally developed paediatric protocols.

Directors of Clinical Governance are required to inform relevant clinical staff treating paediatric patients of the revised protocols.

### REVISION HISTORY

Version	Approved by	Amendment notes
December 2004 (PD2005_389)	Director-General	New policy
April 2006 (PD2006_023)	Director-General	Policy Revised
October 2009 (PD2009_065)	Deputy Director-General Strategic Development	Second edition

### ATTACHMENT

1. Infants and Children: Acute Management of Seizures – Clinical Practice Guideline.

Infants and children:  
Acute Management of Seizures  
second edition

**CLINICAL PRACTICE GUIDELINES**



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NSW Department of Health 2009

SHPN: (SSD) 090179  
ISBN: 978-1-74187-346-7

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A revision of this document is due in 2011.

September 2009 - second edition

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# Introduction

These Guidelines are aimed at achieving the best possible paediatric care in all parts of the state. The document should not be seen as a stringent set of rules to be applied without the clinical input and discretion of the managing professionals. Each patient should be individually evaluated and a decision made as to appropriate management in order to achieve the best clinical outcome.

The formal definition of clinical practice guidelines comes from the National Health and Medical Research Council:

‘systematically developed statements to **assist** practitioner and patient decisions about appropriate health care for specific clinical circumstances.’ (National Health and Medical Research Council, *A Guide to the Development, implementation and evaluation of Clinical Practice Guidelines*, Endorsed 16 November 1998, available from [www.nhmrc.gov.au/publications/synopses/cp30syn.htm](http://www.nhmrc.gov.au/publications/synopses/cp30syn.htm))

It should be noted that this document reflects what is currently regarded as a safe and appropriate approach to care. However, as in any clinical situation there may be factors, which cannot be covered by a single set of guidelines, this document should be

used as a guide, rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. It does not replace the need for the application of clinical judgment to each individual presentation.

This document represents basic clinical practice guidelines for the acute management of seizures in children and infants. Further information may be required in practice; suitable widely available resources are listed in appendix two.

Each Area Health Service is responsible for ensuring that local protocols based on these guidelines are developed. Area Health Services are also responsible for ensuring that all staff treating paediatric patients are educated in the use of the locally developed paediatric guidelines and protocols.

In the interests of patient care it is critical that contemporaneous, accurate and complete documentation is maintained during the course of patient management from arrival to discharge.

**Parental anxiety should not be discounted: it is often of significance even if the child does not appear especially unwell.**

# Changes from previous Clinical Practice Guidelines

The following outlines changes to the document:

- Definitions of hypoglycaemia vary between 2.2 and 3.5. It seems safer in this context to use the higher figure and give IV Dextrose when BGL < 3.5.
- IV midazolam has a short half life in the CNS. It is preferred to diazepam in “Up To Date” and at Sydney Children’s Hospital. For that reason it is mentioned before diazepam in the algorithm.
- IV lorazepam has been shown to be superior to IV diazepam, at least in adults, but is not currently available in NSW.
- Buccal midazolam has been shown to be more effective than rectal diazepam (*Lancet* 2005, McIntyre).
- The optimal dose of buccal midazolam is unclear. A single dose of 0.5 mg/kg was associated with minimal risk of respiratory suppression in the McIntyre study and is also recommended in *Drug Doses 2003* (SHANN ISBN 0-9587434-2-8). The lower dose of 0.3 mg/kg, as used in the existing guidelines, allows for this to be repeated after 5 minutes.
- Paraldehyde is still included in the algorithm. It is not held in all hospital pharmacies, perhaps because of increasing cost, but is still justified by recent literature.
- Fosphenytoin is a pro-drug of phenytoin that is associated with fewer side effects, but is more expensive. It is not currently available in NSW and although, like IV lorazepam, was identified in the original guideline as a potential future direction, is not recommended for inclusion at this stage.
- Pyridoxine dependant seizures are rare — 1:10<sup>6</sup> neonates and are less common outside the neonatal period. IV pyridoxine is only available on special access scheme in NSW. It is held by pharmacies in some major hospitals, but it is not widely available and its use is sometimes associated with adverse effects. It should be given only on the advice of a Paediatric Neurologist.
- Recommendations regarding investigation are made in the light of the review in *Paediatrics 2003* [Freeman: *Paediatrics* 111(1): 194-6 2003 Jan] but also the increasing incidence of hypocalcaemia in NSW.

A request has been made that the reviewed *Clinical Practice Guidelines for Acute Management of Seizures* include comments on drug induced seizures and discharge criteria.

Clinicians should bear in mind that seizures are occasionally induced by toxins, including tricyclic anti-depressants, benzodiazepines, anti-psychotics, salicylates and lead. Anti-convulsant toxicity may also exacerbate seizures. A drug history should be taken, and signs of unexpected autonomic disturbance sought in the examination, including unexpected pupillary signs, pulse rate or blood pressure.

**If toxicity is established, the Poisons Information Centre should be contacted by phone on 131 126 for advice on specific treatment.**

### **Patients should not be sent home without:**

1. Regaining full consciousness.
2. Having a clear plan about management of any recurrence.

### **Reference List:**

1. McIntyre et al, *Lancet* Vol 366; 2005, 205–210
2. Wilson et al, *Arch Dis Child*. 89 (1): 50–1 2004 Jan
3. Treiman et al, *NEJM* 1998; 339; 792-8
4. Qureshi et al, *Seizure* 2002; 11; 141–144
5. Baxter, *International Review of Child Neurology Series* 2001, pp. 109–165
6. Freeman, *Paediatrics*, 111(1): 194–6 2003 January
7. National Institute for Clinical Excellence Guideline on Epilepsy SSP 2004
8. Baumer, *Arch Dis Child*. 2004; 89; 278–280

# Overview

Seizures are a common occurrence in children: about eight per cent will have at least one seizure by 15 years of age. A seizure may be defined as a sudden attack of altered behaviour, consciousness, sensation or autonomic function produced by a transient disruption of brain function. The result of this altered brain function is most commonly a tonic (stiffening) or tonic-clonic (stiffening-jerking) seizure. When the seizure has motor accompaniments, it is also known as a convulsion. Non-convulsive seizures, ie those not associated with motor phenomena may also occur, but are rare and occur usually in the context of a child with a previous diagnosis of epilepsy.

Many underlying conditions and neurological challenges may provoke seizures, and in over 50 per cent of children seizures are isolated events associated with either a high fever (febrile seizures or febrile convulsions) or minor head injury in early childhood. Most acute seizures in children are brief, terminating spontaneously and do not need any treatment. Seizures that persist beyond five minutes may not stop spontaneously and it is usual practice to implement acute seizure treatment when the seizure lasts more than five minutes.

Given that most acute seizures in children stop spontaneously, usually during transit to hospital, it should be assumed that if a child were still convulsing on arrival in the Emergency Department the seizure would continue unless treated. In this situation the child should be treated as if they were in 'established' status epilepticus.

Generalised tonic-clonic (Convulsive) Status Epilepticus (CSE) is defined as a generalised seizure lasting 30 minutes or longer, or repeated tonic-clonic convulsions occurring over a 30-minute period without recovery of consciousness between each convulsion. Although the outcome of CSE is mainly determined by its cause, the duration of the seizure is also relevant and the optimum management is to terminate the seizure rapidly, effectively and safely.

CSE has a mortality in children of approximately four per cent. Neurological sequelae of CSE (epilepsy, motor deficits, learning difficulties, and behaviour problems) are age dependent, occurring in six per cent of those over the age of three years but in 29 per cent of those under one year.

In some children with a diagnosis of epilepsy, a previously individualised acute

seizure management plan devised by the child's paediatrician may be followed and may be administered at home or at school. However, in most children who have acute prolonged seizures, the seizure will be managed by ambulance or hospital staff.

## Initial support

The first step in the management of the patient who is having a seizure is to assess and support airway, breathing and circulation. This will ensure that the seizure does not compromise supply of oxygenated blood to the brain and is not secondary to hypoxia and/or ischaemia.

## Airway

- A clear airway is the first requisite. Assess airway patency by the 'look, listen and feel' method.
- If the airway is not clear it should be opened and maintained with a head tilt/chin lift or jaw thrust manoeuvre and the child ventilated by bag-valve-mask if required. An oropharyngeal or nasopharyngeal airway may be used.
- If the airway is compromised due to the seizure, controlling the seizure with anti-convulsants will generally control the airway.
- Even if the airway is clear, the oropharynx may need secretion clearance by gentle suction. After initial airway clearance the child should be positioned on his or her side.

## Breathing

Assess the adequacy of breathing.

- Effort of breathing:
  - recession
  - respiratory rate
  - grunting – this may be caused by the convulsion and not be a sign of respiratory distress in this instance.
- Efficacy of breathing:
  - breath sounds
  - chest expansion/abdominal excursion.
- Effects of breathing:
  - heart rate
  - skin colour.

Monitor oxygen saturation with a pulse oximeter.

- All fitting children should receive high flow oxygen through a face mask with a reservoir as soon as the airway has been demonstrated to be adequate.
- If the child is hypoventilating, respiration should be supported with oxygen via a bag-valve-mask device and experienced senior help summoned.
- **Prolonged seizures and/or repeated doses of anti-epileptic medications may lead to compromise of breathing requiring ongoing support including intubation. Help from senior clinicians should be obtained for intubation.**

## Circulation

- Assess the adequacy of circulation by palpation of central pulses (femoral, brachial) check central capillary refill (should be less than two seconds). Gain intravenous access. If vascular access is not readily obtained, initial doses of anti-convulsants should be given by the rectal, intramuscular or buccal routes.
- Intraosseous access (IO) should be obtained immediately in children with signs of shock if intravenous access is not readily obtained. IO access may be needed for administration of long-acting anti-convulsants if there is no intravenous access after two doses of a benzodiazepine.
- Take blood glucose stick test and laboratory test. Give 5 mL/kg of 10 per cent dextrose to any hypoglycaemic patient. If possible, take 10 mLs of clotted blood before giving the dextrose for later investigation of the hypoglycaemic state.
- Give 20 mL/kg rapid bolus of normal saline to any patient with signs of shock.
- Give a broad spectrum antibiotic (third generation cephalosporin) to any child in whom a diagnosis of meningitis or septicaemia is suspected after blood has been taken for culture.
- Check blood pressure as soon as the seizure has finished.

## Technique of buccal Administration

Buccal administration of midazolam can be achieved by trickling the appropriate dose between the lower cheek and gum with the patient in the recovery position. This technique aids absorption directly through the buccal mucosa, providing more rapid absorption than if the midazolam was swallowed.

## Disability

Assess neurological function.

- The AVPU (Alert, Voice, Pain, Unresponsive) score cannot be measured meaningfully during a seizure as a generalised seizure depresses the level of consciousness.
- Pupillary size, reaction and symmetry should be noted. Pupillary changes can occur during a seizure but may also result from poisoning or raised intracranial pressure. Very small pupils suggest opiate poisoning, large pupils suggest amphetamines, atropine, tricyclics.
- Document any focal neurological signs, either during or after the seizure.
- Note the child's posture. Decorticate or decerebrate posturing in a previously normal child should suggest raised intracranial pressure. These postures can sometimes be mistaken for the tonic phase of a seizure. Consider also the possibility of a drug-induced dystonia that is distinguishable from tonic-clonic status epilepticus.

- Look for neck stiffness in a child and a full fontanelle in an infant, which suggests meningitis.
- Prolonged seizures and/or repeated doses of anti-convulsant medications may cause prolonged depression of consciousness and lead to compromise of airway and breathing, requiring ongoing support including intubation.

## Exposure

- Look for rash and bruising as signs of sepsis or injury.

## Reassess ABC

The vital signs should be reassessed frequently, in addition to continuous monitoring with ECG and oximetry:

- after each dose of anti-epileptic medication
- every 15 minutes while the seizure continues
- every 30 minutes after a seizure until level of consciousness returns to normal.

## Specialist consultation/transfer

If in doubt or confused about a child's clinical condition, signs or symptoms, consult with someone more experienced such as a paediatric specialist. If a specialist is not available, call NETS (the NSW Newborn and paediatric Emergency Transport Service on 1300 362 500. They

will set up a conference call which includes a paediatrician and other relevant paediatric specialists as well as organise urgent transfer of a child to a paediatric centre if necessary.

The treating doctor should consult with a specialist about:

- children with compromise of vital functions:
  - airway compromise requiring intubation
  - breathing compromise e.g. persistent hypoventilation, aspiration
  - circulatory compromise e.g. requiring more than 20 mL/kg fluid bolus
  - neurological compromise e.g. localizing signs – focal fit, asymmetry of movement, asymmetry of reflexes; prolonged depression of level of consciousness
- prolonged seizures
- seizures continuing after two doses of a benzodiazepine
- suspected serious underlying cause of seizures e.g. meningitis, metabolic abnormality, head injury.

## Cardiovascular status

- Heart rate – the presence of an inappropriate bradycardia will suggest hypoxia or raised intracranial pressure
- Pulse volume
- Capillary refill

- Blood pressure – significant (> 97th percentile for age) hypertension indicates a possible aetiology for the seizure
- Effects of circulatory inadequacy on other organs
- Pale, cyanosed or cold skin.

## Monitor heart rate/rhythm, blood pressure

Whilst the primary assessment and resuscitation are being carried out, a focused history of the child's health and activity over the previous 24 hours and any significant previous illness should be gained.

Specific points for history taking include:

- Current febrile illness
- Neurologic state prior to the seizure
- Recent trauma
- History of epilepsy
- Current medication and allergies
- Recent immunisation
- Poison ingestion including lead, tricyclic anti-depressants, benzodiazepines, anti-psychotics and salicylates. Anti-convulsant toxicity may also exacerbate seizures
- Past medical history, immunisations.

## Medication used in acute seizures

Buccal midazolam: 0.3 mg/kg.

Midazolam: intravenous/intraosseous/intramuscular, 0.15 mg/kg.

Midazolam: intra-nasal, 0.3 mg/kg.

Diazepam: intravenous/intraosseous, 0.25 mg/kg.

Diazepam: per rectum, 0.5 mg/kg (maximum 10 mg).

Phenytoin: intravenous/intraosseous, 20 mg/kg in normal saline over 20 minutes with ECG monitoring.

Phenobarbitone: intravenous/intraosseous 20 mg/kg.

Paraldehyde: per rectum, 0.4 mL/kg mixed with equal volume of normal saline or olive oil.

Pyridoxine: 50–100 mg IV slow IM injection and not above 200 mg.

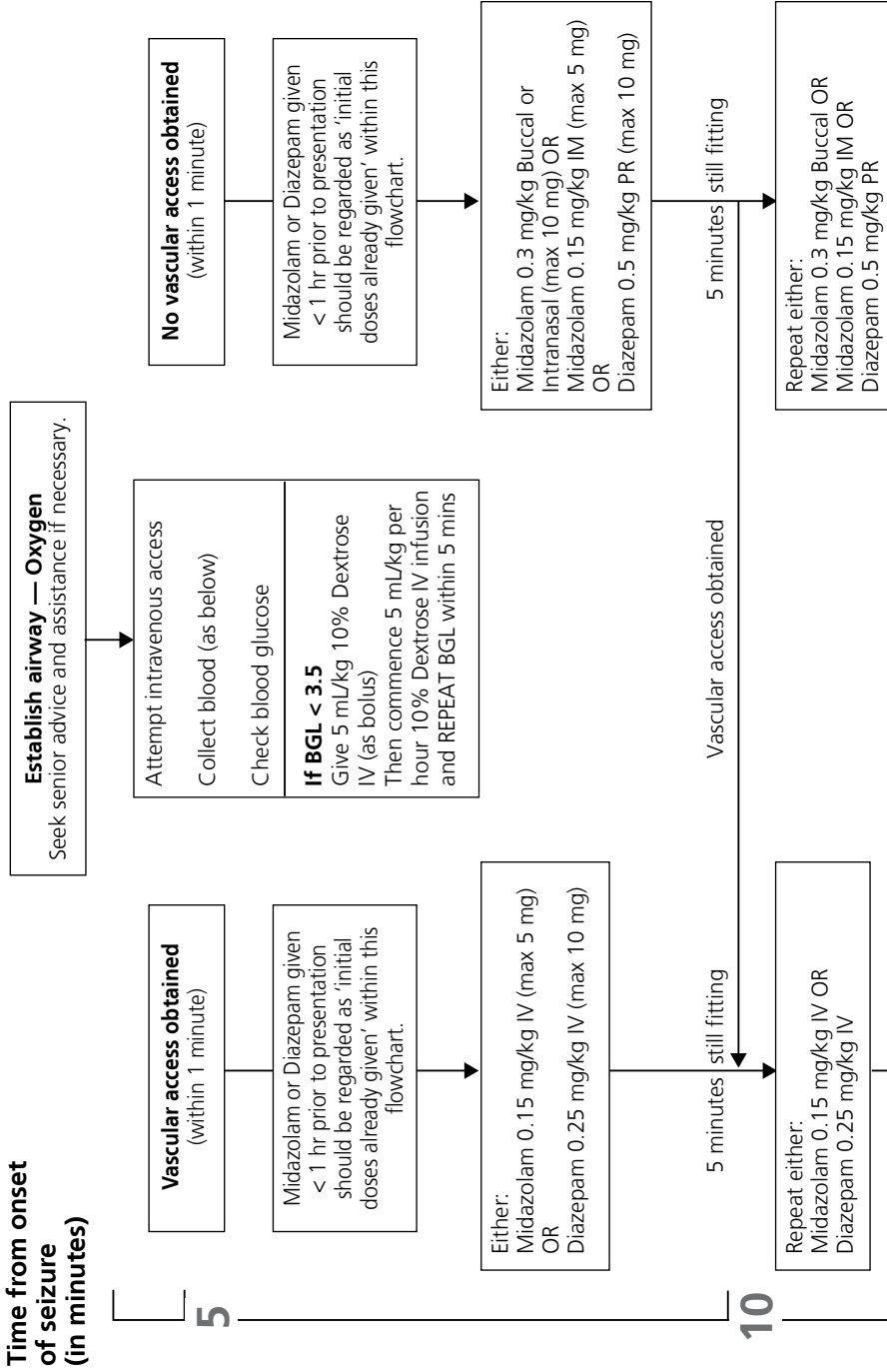
NSW Ambulance Service protocol issued June 2005:

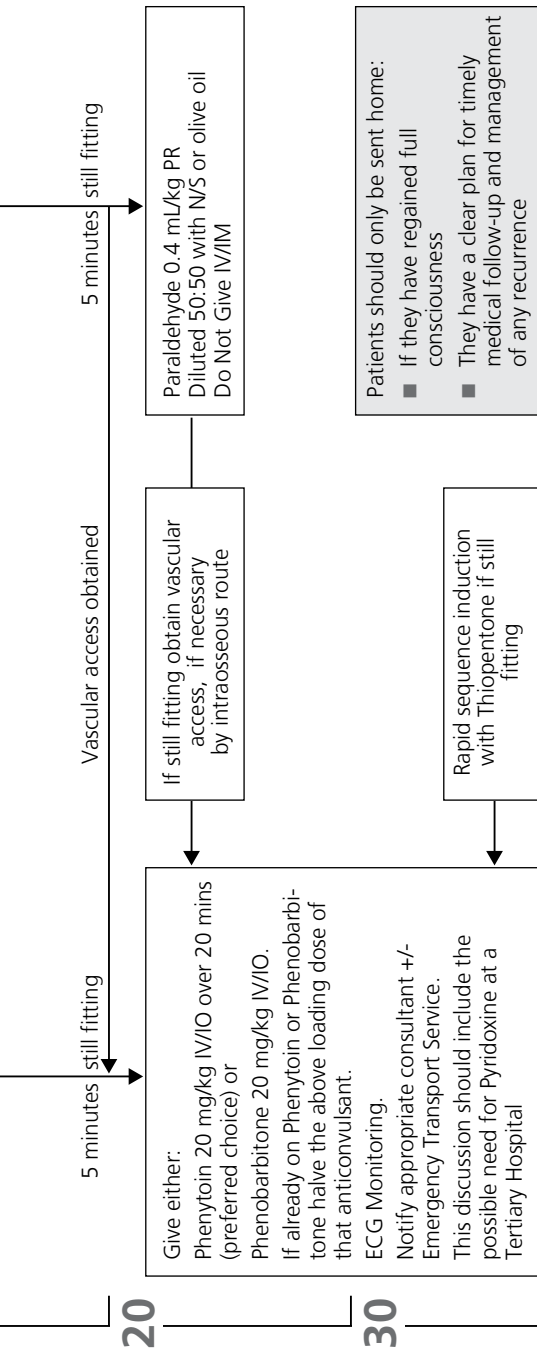
*Intra-nasal:* 0.3 mg/kg undiluted midazolam (5 mg/1 mL) via Mucosal Atomising Device (MAD) with dose equally distributed into each nostril. If fitting continues, can be repeated once after 10 minutes. Each IN dose must not exceed the adult IM dose of 7.5 mg (1.5 mL).

*IM:* 0.15 mg/kg of undiluted midazolam by IM injection, if unable to gain intravenous access. If fitting continues, dose can be repeated once after 5 minutes.

*IV:* 0.15 mg/kg of diluted midazolam by slow IV injection. If fitting continues, dose can be repeated every 3 minutes until fitting ceases, to a maximum of 3 doses (0.45 mg/kg).

# ASSESSMENT AND INITIAL MANAGEMENT





Maintain continuous monitoring of pulse, respiratory rate, oximetry whilst the child is still fitting or unconscious.

### Seizure Terminated

- Position child in Recovery position, on left side. Maintain airway (jaw thrust, chin lift, suction).
- History/examination: Search for underlying cause (head injury, sepsis, meningitis, metabolic). And include localisation of infection when febrile (when appropriate refer to other Clinical Practice Guidelines e.g. Fever, Meningitis, Recognition of the Sick Child). A drug history should be taken, and signs of unexpected autonomic disturbance sought in the examination, including unexpected pupillary signs, pulse rate or blood pressure. If toxicity is established, contact the **Poisons Information Centre on 131126** for advice on specific treatment.
- Blood Glucose should be measured in any child who is continuing to fit, or has not regained full consciousness at presentation. EUC should be collected if there has been repeated diarrhoea or vomiting. Anticonvulsant levels should be measured if previously regularly administered. Calcium should be measured on first presentation of fits without fever. Blood count and culture should be collected if a child has prolonged seizure with fever, or if sepsis is suspected. Cerebral imaging should be arranged if seizure has been focal. Lumbar Puncture should be arranged if meningitis is suspected and there are no contra-indications (See Meningitis Management Guidelines.)
- Consider antibiotics if bacterial sepsis cannot be excluded.

# Evidence base for use of antiepileptic drugs

The immediate emergency treatment requirement, after ABC stabilisation and exclusion or treatment of hypoglycaemia or hypocalcaemia<sup>46</sup> is to stop the convulsion.

The approach to the antiepileptic drugs (AED) used in the acute medical management of seizures has developed since the availability of intravenous diazepam in the mid 1960s.<sup>1</sup> Drug of first choice is now a benzodiazepine on the basis that this will achieve rapid seizure control with minimal side effects in the majority of children. Such drugs act quickly by several routes, can be given again within a short space of time and may be all that is required.

Second line AED, for refractory seizures, should be compatible with such first line AED, should ideally work synergistically without contributing to side effects and be more effective in preventing ongoing seizures. Phenytoin and phenobarbitone remain the cornerstone of second line therapy.

In choosing AED, the desired outcome of most rapid cessation of acute seizures with smallest possible incidence of side effects at minimal cost was chosen. Requirements

of such medications include ease of administration and rapid appearance in the CSF. Consideration was also given to variation in regional availability of AED. Early treatment is essential, as once seizures are established for more than 15 minutes, they become more difficult to treat.<sup>2</sup>

Current protocols used at all three children's hospitals in NSW were also reviewed.

The most up to date is based on the Advanced Paediatric Life Support (APLS) recommendations, which have their origin in the UK. These in turn bear a close similarity to the protocol developed by the British working party in 2000. The English language literature with an eye to level of evidence was reviewed.

Some practice is historically accepted, some more evidence based with variations based on regional availability of AED. A conscious effort was made to consolidate regional practice rather than completely redesign the current protocols, provided no contradictory evidence to this was noted. Happily most of this already conformed closely to best practice guidelines.

The latest review of these guidelines confirmed that they have been well-

received and used, and need relatively little modification. Some changes have been made in light of recent evidence and are referenced appropriately. Where evidence for change appears to be lacking, the guideline remains unchanged. Seizures should preferably be controlled within 15 minutes.

## First line therapies

- Diazepam
- Midazolam
- Lorazepam
- Paraldehyde.

**Diazepam** has been used both intravenously and rectally since 1965<sup>1,4,5,6</sup> for the first line control of status epilepticus. Intravenous administration produces rapid control of seizures in approximately 80 per cent of patients. After rectal administration, therapeutic serum levels are seen within five minutes<sup>7</sup> and rapid seizure control occurs in up to 80 per cent.<sup>6,8</sup> Whilst there may be benefit from subsequent IV diazepam in those not responding, seizures resistant to a single rectal dose correlate with seizures resistant to all acute therapies and those needing 'second line treatments'.<sup>7</sup>

**Midazolam** has now replaced diazepam as drug of first choice before venous access has been obtained, because of improved effectivity and preferred route of administration (buccal vs rectal). Midazolam was used initially as a second line AED in

refractory status epilepticus.<sup>14</sup> It is, however, highly effective as a first line anti-convulsant stopping the majority of seizures within one minute after IV injection of 0.1–0.3 mg/kg<sup>15,16</sup> and IM within 5–10 minutes. It has superior absorption in comparison with diazepam and lorazepam when given IM because of its water solubility.<sup>17,18</sup> Intra-nasal & IM midazolam has been adopted by the NSW Ambulance Service as the drug of first choice in status epilepticus.<sup>19</sup>

A single dose of buccal midazolam 0.5 mg/kg has been shown to carry minimal risk of respiratory suppression.<sup>39</sup>

Studies have shown conflicting results regarding side effects of diazepam. Earlier studies found no major respiratory depression in doses of 0.5 mg/kg with maximum doses of 10–20 mg.<sup>7,6,8,9</sup> A recent study has identified a nine per cent risk of respiratory depression warranting either bag and mask oxygen or ventilation. The majority of these children had received rectal diazepam with maximum PR dose at 0.83 mg/kg.<sup>10</sup> Most authors recommend half the normal rectal dose in children with prior CNS abnormalities who are naive to diazepam.

A potential disadvantage is the apparent lessening of efficiency of diazepam with repeated doses compared with lorazepam.<sup>11</sup>

**Lorazepam IV** is used in North America and the UK. There is evidence of longer duration and reduced need for repeated

doses.<sup>12</sup> There is suggestion of more success over IV diazepam in control of acute seizures with a similar side effect profile although this did not reach statistical significance.<sup>13</sup> There is significant difference in comparison with diazepam in the reduced need for second dose.<sup>11</sup> Although there is evidence for advantage in adults, the evidence is less convincing in children, it is currently available on SAS scheme only in Australia. There may be more resistance to its effects in children on regular benzodiazepines.<sup>12</sup>

**Paraldehyde** has been in use since 1884 and has been used rectally for the treatment of seizures since the early 1930s. Paraldehyde is now given exclusively rectally mixed in an equal volume of suitable oil. Olive oil is now being recommended over arachis oil.<sup>2,21,22</sup> Descriptions of major toxicity are associated with IV use.<sup>23,24,25</sup> Although there is little high level evidence in the literature, rectal administration is widely held to be tolerated well, produces rapid onset of seizure control and is associated with less respiratory depression in repeated doses than the benzodiazepines. It has been subject to supply problems in NSW but it has been indicated that this is unlikely in the future.

## Second line anti-convulsants for refractory status epilepticus

- Phenytoin
- Phenobarbitone
- Fosphenytoin
- Valproate.

**Phenytoin** has been available since 1938 and was introduced as the first non-sedating anti-convulsant. It has been used as a drug of choice for some time.<sup>13,26,27</sup>

In intravenous doses of 20 mg/kg for children, seizures are well controlled in 60–80 per cent within 20 minutes.<sup>28</sup> It has much less potential for respiratory depression than phenobarbitone particularly following benzodiazepine administration.<sup>29</sup> It has been adopted as the first choice of second line anti-convulsants by the British working party.<sup>22</sup> Side effects in doses and levels within the therapeutic range, and at prescribed administration rates, are circumscribed.

The main theoretical risk of rapid acute therapy is asystole although with administration rates of max 50 mg/min this is not seen in normal children. Additives such as propylene glycol, alcohol and a high pH are held responsible. Mild decrease in pulse rate or blood pressure can be controlled by slowing the infusion rate.<sup>13</sup>

Phlebitis is probably the most common minor effect.<sup>30</sup> Concurrent use of phenytoin with benzodiazepines results in a faster onset of therapeutic effect.<sup>29,31</sup> Although several combination regimes were compared albeit in adults<sup>32</sup> there was no significant difference.

The advantage of its close relative fosphenytoin is the reduced potential for cardiac effect of dysrhythmia and hypotension as well as less severe extravasation consequences.<sup>22</sup> Whilst it may be infused more rapidly than phenytoin, time to peak levels is identical and the cost is very significantly higher. A small advantage for a high cost which currently excludes it from our recommendations.

**Phenobarbitone** has been used in seizure control since 1912 and is used worldwide.

It is 'well established, cheap and highly effective'.<sup>29,33</sup> After intravenous loading there is a biphasic distribution and highly vascular organs, excluding the brain, benefit first. Although penetration to the brain has been reported to occur 12–60 minutes after administration,<sup>34</sup> this may happen faster in status epilepticus because of increased cerebral blood flows.

In combination with prior administration of benzodiazepines, there is a risk of respiratory depression. It is used as the second line AED of choice in the neonatal period.<sup>35</sup> In addition, it can be given after

a load of phenytoin, often with additive effect. The converse is true.<sup>29</sup>

In children already on phenobarbitone as maintenance therapy, the widespread strategy of giving a 5–10 mg/kg load even without knowing current levels, is often used with benefit. A similar strategy is seen in high dose protocols which use sequential phenobarbitone loading as high as 130 mg/kg.<sup>36</sup> Cumulative loads of at least 40 mg/kg are regularly tolerated without respiratory depression.

A preparation of IV **sodium valproate** is available on SAS in Australia. Because of the risks of hepatotoxicity in infants and young children, it has not been adopted as standard second line treatment.<sup>37</sup>

Pyridoxine dependent seizures appear most often postnatally and rarely (1 in 1,000,000) later in the first two years of life. Accordingly, it has been indicated that intravenous therapy ought to be considered in children with resistant status epilepticus under the age of two.

A slow intravenous injection 50–100 mg (and not above 200 mg) is accepted practice.<sup>38</sup> IV pyridoxine is not widely available, and its administration is not without potential for exacerbating seizures. It is not recommended without prior discussion with a Paediatric Neurologist.<sup>45</sup>

# Appendices

## Appendix One – References

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Please note that an international literature search (for the past 5 years) has been carried out in addition to references quoted in the previous edition.

## Appendix Two – Resources

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Fuller details may be necessary in practice, especially for the management of infants and children with seizures. Possible sources include:

NSW Health Department CIAP website, Managing Young Children and Infants with Seizures in Hospitals at: [www.ciap.health.nsw.gov.au](http://www.ciap.health.nsw.gov.au) also the

Children's Hospital Westmead Handbook, 2004 available as a book from the Children's Hospital at Westmead or at [www.chw.edu.au/parents/factsheets](http://www.chw.edu.au/parents/factsheets)

Seizures Fact Sheet jointly developed by the John Hunter Children's Hospital, Sydney Children's Hospital and Children's Hospital at Westmead at:

[www.kaleidoscope.org.au/parents/factsheets.htm](http://www.kaleidoscope.org.au/parents/factsheets.htm)

[www.sch.edu.au/health/factsheets](http://www.sch.edu.au/health/factsheets)

[www.chw.edu.au/parents/factsheets](http://www.chw.edu.au/parents/factsheets)

## Appendix Three – Parent information

A Seizures Fact Sheet jointly developed by John Hunter Children's Hospital, Sydney Children's Hospital and Children's Hospital at Westmead is available at:

[www.kaleidoscope.org.au/parents/factsheets.htm](http://www.kaleidoscope.org.au/parents/factsheets.htm)

[www.sch.edu.au/health/factsheets](http://www.sch.edu.au/health/factsheets)

[www.chw.edu.au/parents/factsheets](http://www.chw.edu.au/parents/factsheets)

*Disclaimer: The fact sheet is for educational purposes only. Please consult with your doctor or other health professional to ensure this information is right for your child.*

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