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1. **In a patient having a seizure:**
    a. **Ensure proper airway control (e.g., oropharyngeal airway or nasal trumpet, lateral decubitus to prevent aspiration).**

    b. **Use drugs (e.g., benzodiazepines, phenytoin) promptly to stop the seizure, even before the etiology is confirmed.**

This first objective is all about the management of an active seizure and the first thing to remember is that while seizures can be quite scary for everyone involved, the interventions are relatively straightforward. So stay calm!

The objectives would like us to touch on airway control during a seizure. The main intervention here is to turn the patient to their side, ie the recovery position, as well as suctioning as needed. These two help with secretions and aspiration risk. Other interventions include supplemental oxygen, though this can be challenging to administer safely, and airway adjuncts like nasal trumpets which could be helpful in certain situations where maybe there is collapse or obstruction of the upper airways. However, there is still a risk of triggering a gag reflex with bite blocks and oral devices which could cause vomiting.

You should be monitoring SpO2 throughout the seizure, since decreasing oxygenation is an indication to intubate the patient for definitive airway control. This has the added benefit of stopping the seizure.

Despite the objective suggesting that these adjuncts are commonplace, I was unable to find any evidence for their use. The docs I talked to also never have used these.
The Alberta guidelines on seizure management don't even mention airway management, except for in the post-seizure patient that may have a decreased LOC due to medications. The Ontario guidelines don't even do that.

In summary, just turn the patient to their side, suction their secretions and monitor the SpO2.

Regarding the use of drugs in active seizures, we don't routinely give drugs at the onset of a seizure. Most are short lived and resolve within a minute or less. However, after 5 minutes, it's considered status epilepticus and you'll want to act quickly. Older definitions used 30 minutes for status, but this is too long. We now know the longer it goes on for the more likely the patient is to have serious or permanent sequelae. The International League Against Epilepsy task force states 30 minutes as the hard cut off, after which permanent brain changes are likely to occur. So in reality the goal is to abort the seizure as soon as possible, and I would be ordering my first round of medication at the 2 minute mark, knowing it will take a few minutes to draw them up, and that way I'm administering it by the time status is officially diagnosed.

The alternate definition for status is 2 or more seizures without a return to normal between them. This is an indication to give medications at the start of that second seizure. No need to wait for 5 minutes.

There are lots of options for antiseizure medications, but some are quicker acting or more effective than others. Typical initial abortive therapy is with benzodiazepines. Midazolam and lorazepam are easy to remember - with the dosing of 0.1mg/kg. Midaz can be given IV, IM or intranasal. Lorazepam absorption is unreliable via IM so it can only be given IV. For a moderate sized adult you're likely looking at 10mg midazolam or 8mg lorazepam. UTD suggests lorazepam IV as first choice, but I prefer midaz due to routes of administration and slightly faster onset. Either will work, or not.

At 10 minutes, if still not stopped, repeat the benzodiazepine, and continue to monitor for any change in vitals that would necessitate those airway interventions talked about earlier.

At 15 minutes you will want to start another agent. Typically this is phenytoin or fosphenytoin at 20 phenytoin equivalents/kg IV at 100-150 phenytoin equivalents/min. You need an IV or IO for this, so be prepared early. Also note that this takes a while to prepare so order this at the 5 minute mark, once you've diagnosed status epilepticus, knowing you need to give it either way.

If the seizure still doesn't stop by 30 minutes, ie 15 minutes after the phenytoin started, you need to switch tactics and either go for phenobarbital or propofol. Last year phenobarbital was shown to be highly effective at aborting the seizure in children, but this isn't as commonly used as propofol due to ease of access in the ED and familiarity with use. The dose for phenobarb 20 mg/kg at 50-100 mg/minute. The dose for propofol is 1-2 mg/kg push then an infusion of 20 mcg/kg/min and titrate up.

c. Rule out reversible metabolic causes in a timely fashion (e.g., hypoglycemia, hypoxia, heat stroke, electrolytes abnormalities).

Seizures are caused by either 1. deficiency of substrates essential for cellular metabolism or membrane function, 2. intracellular accumulation of toxic substances or 3. alteration of intracellular osmolality. With that in mind the differential for seizure includes:

- Alcohol & drug use or withdrawal
- Drug intoxication
- Hyponatremia, hypernatremia
- Hypomagnesemia
- Hypocalcemia
- Hypoglycemia
- Hyperthermia - either febrile seizure or from truly elevated body temperature
- Nonketotic hyperglycemia
- Uremia
- Hypoxia
- Hyperthyroidism
- Dialysis disequilibrium syndrome
- Porphyria
- Sleep deprivation
- CNS infections
- Trauma - this is mild to moderate head trauma followed immediately by a tonic clonic seizure.
- As well an underlying seizure disorder.

You can rule most of these out by history, physical, vitals like a bedside glucose, temperature, and SpO2, or by lab work.

A typical initial work up will include a CBC, lytes, creatinine, urea, glucose, extended lytes, tsh, CRP. The inclusion of drug and alcohol testing may be of use in some situations, but its utility has been questioned. We'll discuss further testing shortly.

2. **In a patient presenting with an ill-defined episode (e.g., fits, spells, turns), take a history to distinguish a seizure from other events.**

3. **In a patient presenting with a seizure, take an appropriate history to direct the investigation (e.g., do not over investigate; a stable known disorder may require only a drug-level measurement, while new or changing seizures may require an extensive work-up).**

4. **In all patients presenting with a seizure, examine carefully for focal neurologic findings.**

We're going to combine objectives 2, 3 and 4 together here because they're all about the history and physical.

It is important to establish if a seizure actually occurred by using all the information you can gather. Distinguishing a seizure from other events like a syncope can be challenging, especially given the wide variation in seizure presentations. Add to that the fact that a patient's recollection of the seizure is almost never complete, and may be entirely void of useful information.

Luckily there are a few things that can help us determine if this is a seizure or not.
First, look for the typical post-ictal period which can involve amnesia, confusion, lethargy, sleepiness, headaches and muscle aches, transient focal weakness (aka Todd's paresis) and nausea or vomiting.

Next, observer reports of the event are much more helpful in differentiating between seizure and syncope, and this can basically clinch the diagnosis of seizure compared with patient only reports.

Be sure to ask about seizure triggers and contributors. Triggers are things experienced immediately prior to the event and can include strong emotions, intense exercise, loud music, and flashing lights. Other contributors include fever, menstruation, lack of sleep, pregnancy, and stress. You'll also want to know about their past medical history including previous seizures, medications, substance use, and family history.

After getting a good history, do your physical exam. This should involve a complete neurologic exam from head to toe, including checking for meningeal signs and identifying any localizing findings. Presence of these can help dictate the work up needed. Physical can also include checking for a tongue laceration as tongue biting has a sensitivity of 24% and a specificity of 99% for the diagnosis of generalized tonic-clonic seizures and lateral tongue biting is 100% specific to generalized tonic clonic seizures.

It's unclear if urinary incontinence is helpful in distinguishing between seizure and syncope so not really worth asking about.

If an unwitnessed seizure has already finished prior to arrival and you're wanting to confirm this, you can order things like CK, VBG, anion gap, and lactate.

CK is 98% specific and 43% sensitive for a tonic clonic seizure if the sample is within 3 hours of the event. Outside of this window is less specific and less sensitive.

Anion gap metabolic acidosis is also associated with generalized seizure. The Denver Seizure Score which uses bicarb and anion gap in its calculation suggests that a score greater than 20 predicts generalized seizure, though from their data it looks to be a bit more continuous than a hard cutoff at 20. For comparison the median score for syncope was 4, vs 24 for the seizure group. Keep in mind this is not yet a validated tool, and frankly I had a hard time finding the actual equation for it, which is:

$$\text{Denver Seizure Score} = [(24 - \text{BICARB}) + (2 \times (\text{AG} - 12))]$$

If you found either meningeal signs or focal deficits, or there are other concerns on lab work etc, then an LP or CT are warranted.

The Ontario guidelines suggest performing a lumbar puncture in children less than 6 months, anyone with persistent altered mental status or failure to return to baseline, or if meningeal signs are present.

CT should be considered in adults with a first seizure given the potential for intracranial bleeds, strokes, and brain tumors to present with seizures. Adult patients with a concerning history or focal findings on physical should probably receive a CT. Children should be scanned if it's a first afebrile seizure if there's an abnormal neuro exam, a history significant for closed head injury, recent CSF shunt revision, malignancy or neurocutaneous disorder, or age less than 6 months, or if there was a focal seizure onset.

EEG is likely needed, but this is something the neurologist will order. So refer these patients to neurology.

5. **In a patient with a previously known seizure disorder, who presents with a seizure or a change in the pattern of seizures:**
    a. **Assess by history the factors that may affect the primary seizure disorder (e.g., medication compliance, alcohol use, lifestyle, recent changes in medications [not just antiepileptic medications], other illnesses).**

I think this is fairly straightforward from the objective. Ask them if they've been taking the medication as prescribed. Have there been changes to any of their medications - antiepileptics and otherwise. Has their weight changed? Have they started using alcohol or other drugs. Are they sleeping regular hours, or do they have undue stress currently.

    b. **Include other causes of seizure in the differential diagnosis. (Not all seizures are caused by epilepsy.)**

Patients with a known seizure disorder with a change in their seizures should be assessed for all the same causes as anyone else, so go through the differential and rule things out.

6. **In the ongoing care of a patient with a stable seizure disorder:**
    a. **Regularly inquire about compliance (with medication and lifestyle measures). side effects of anticonvulsant medication, and the impact of the disorder and its treatment on the patient's life (e.g., on driving, when seizures occur at work or with friends).**

Asking about compliance is likely best done by asking a patient when they are taking their medication and how much. Simply asking a yes/no "are you taking your meds" could make a patient feel pressured to say yes or lie about their exact compliance. Anyway ask patients at every visit. Also ask about the lifestyle contributors we talked about earlier.

Then FIFE them. Determine how they're feeling, if their function is impaired and what they'd like or hope to get help with.

Specific side effects of antiepileptic drugs include:

- Drowsiness, fatigue, and insomnia;
- dizziness, vertigo, ataxia, diplopia, tremor;
- cognitive impairment; irritability, aggressive behaviour, depression;
- gastrointestinal symptoms;
- Hyponatraemia;
- paresthesias

There are also a couple interactions between antiepileptics and other drugs. These include:

- rash after adding lamotrigine to valproate;
- reduced seizure control after adding the combined contraceptive pill to lamotrigine;
- reduced effectiveness of warfarin after adding carbamazepine;
- increased risk for CNS neurotoxicity after combination of sodium-channel-blocking antiepileptic drugs

Best to use an interaction checker!

b. Monitor for complications of the anticonvulsant medication (e.g., hematologic complications, osteoporosis).

Several longer term complications from these medications include:

- Decreased bone mineral density;
- weight gain, weight loss;
- folate deficiency;
- connective tissue disorders;
- hirsutism, gingival hypertrophy;
- Alopecia;
- visual field loss

c. Modify management of other health issues taking into account the anticonvulsant medication (e.g., in prescribing antibiotics, pregnancy).

Let’s talk about women of childbearing potential and antiepileptic drugs. These drugs, especially valproate, can cause teratogenic effects as well as reproductive endocrine disorders such as polycystic ovary syndrome and hyperandrogenism. If you have a patient that fits in this category they should be using two forms of contraception, and be referred back to their neurologist well in advance if they are looking to get pregnant. They may need to be titrated to a different medication, and that can take time.

Speaking of contraception, there are interactions between antiepileptic drugs and oral contraceptives: enzyme-inducing antiepileptic drugs reduce the effectiveness of oral contraceptives AND oral contraceptives increase clearance of lamotrigine and valproate, potentially leading to breakthrough seizures. So really not a good situation here! Perhaps suggest non-OCP contraceptive options like an IUD to these patients.

That’s it for seizure!

To recap management of an active seizure is:
Support airway and breathing and prevent aspiration by turning them to their side, and using suction and supplemental oxygen.
At 5minutes administer a benzodiazepine.
At 10 minutes, repeat the benzo
At 15 phenytoin or fosphenytoin
At 30 minutes phenobarbital or propofol and intubation.