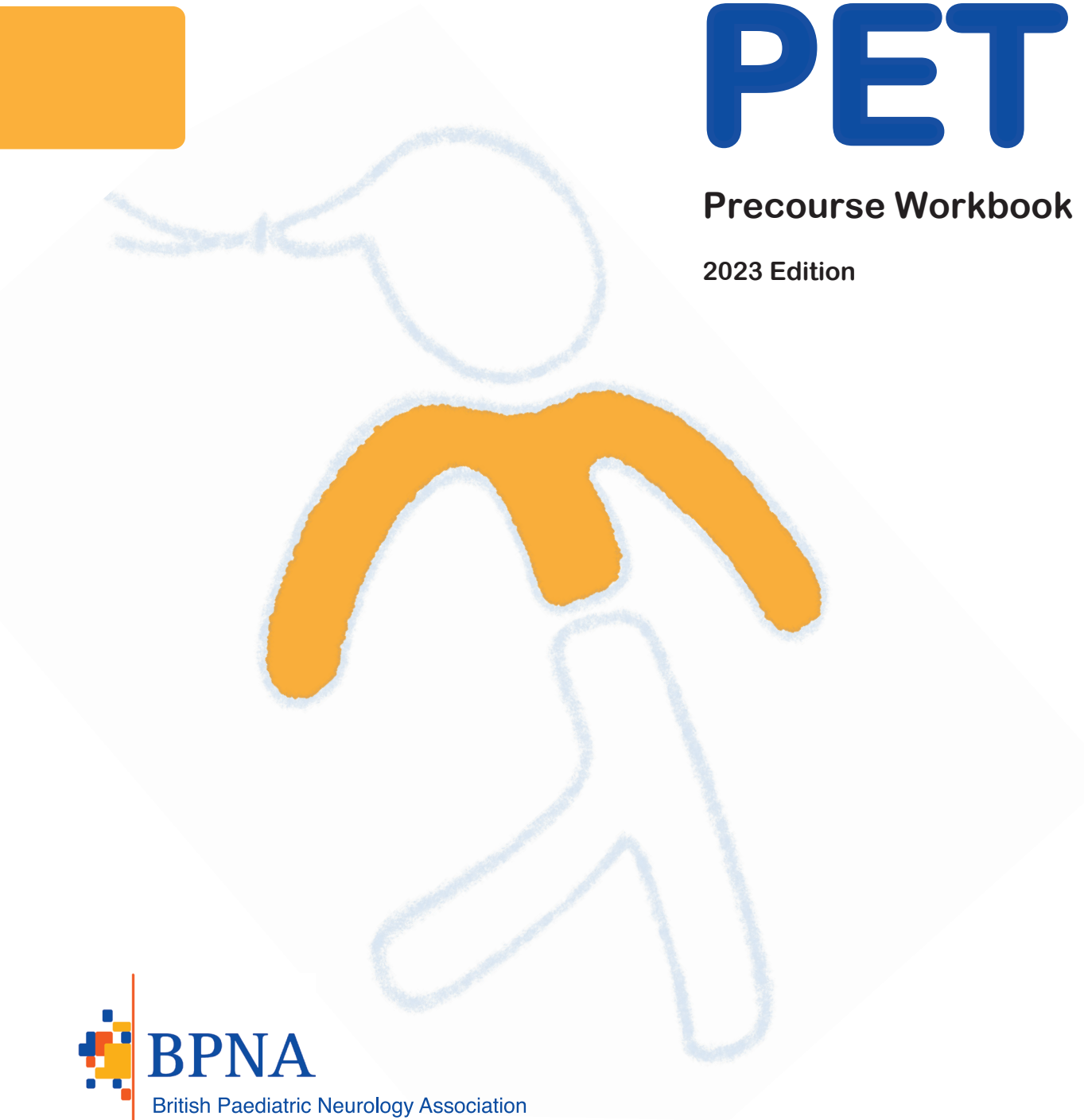
PET 1 2 3
PAEDIATRIC EPILEPSY TRAINING

PET 1

Precourse Workbook

2023 Edition



BPNA
British Paediatric Neurology Association
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Contents

1. HOW YOU SHOULD USE THIS HANDBOOK

This book is designed to provide you with key facts about childhood epilepsies. It covers the same sort of ground as the training day. It is hoped that by working through the book before the training day you will come to the training day better prepared and therefore more able to fully participate in the sessions.

There are four things you should note:

1. To maintain your interest a number of tasks are given, however, you may not be able to do the tasks. Don't worry! It is hoped that you will be able to after you have completed the PET training.

2. The core material for the course is the text in black and bold. This is considered the essential information, which participants who complete a PET1 course should know at the end of the course. Text highlighted in bold indicates key practice points. Of course, depending on your location, profession or discipline, these may be more or less important to you.

3. The text in boxes is what the National Institute for Clinical Excellence (NICE), UK says about a particular topic. It is important that you remember that it is not part of the core material, and you should not necessarily try to memorise it. However, it is recommended that you at least skim over it. It is included so that if a particular topic is especially relevant to your own practice, you are aware of this or your own national policy in the area.

4. Included at the end of each section is additional information about topics covered in the main part of the text. This is material which goes beyond that needed to successfully complete PET1. However, it is hoped that many of you will have your appetite whetted and will wish to know more, perhaps taking a further PET2 or PET3 course or BPNA distance learning. The material here can be seen as a bridge towards these other PET courses. However, if you wish, you can ignore it completely!

Finally, there may be words used in the text with which you are unfamiliar – don't despair. At the end of the book, you will find a glossary of terms. Terms which are included in the glossary are indicated in italics.

2. WHAT IS AND WHAT IS NOT EPILEPSY?

2.1 Introduction

In this section you will explore what epileptic seizures are, what epilepsy is, and what disorders can be confused with epilepsy.

2.2 Learning Objectives

By the end of this section, you will:

- Know key epidemiological facts concerning epilepsy
- Know modern terminology used in clinical epileptology
- Be able to give precise definitions of key terms
- Be able to explain in terms understandable to the non-specialist what epileptic seizures are
- Be able to give a simple classification of epileptic seizures and of the different types of epilepsy
- Be able to describe key clinical features which may occur during epileptic seizures
- Be able to list important disorders which may be confused with epilepsy
- Explain why misdiagnosis of epilepsy is common

2.3 Terminology – the good the bad and the ugly!

Task 1:

Having a common vocabulary is essential for effective communication. A bewildering array of terms is used in *epileptology*. Some of these are precise and add clarity when used appropriately, others are imprecise and liable to lead to confusion and some, although still used, are best considered obsolete.

The following is a list of terms that are or have been used in clinical epileptology. Put a tick beside those you think have a precise meaning (and should be used), crosses beside those that you think are obsolete (and best left for the dinosaurs) and question marks besides those that are imprecise and need to be used with care.

Term	✓*Precise*	*X Obsolete*	*? with care*
Convulsion			
Grand mal			
Seizure			
Petit mal			
Epileptic seizure			
Fit			

Commentary 1:

The only precise term in the list is 'epileptic seizure'. We will look at the definition of this shortly.

The term '*seizure*' can be used to denote any paroxysmal event from whatever cause. Thus, it might be applied to a faint, a severe headache or even a stroke as well as a manifestation of epilepsy. Perhaps its most familiar use, outside epilepsy, is as 'reflex anoxic seizure', a common form of non-epileptic event mainly occurring in infants and young children. Often in practice the term 'seizure' is often used synonymously with 'epileptic seizure' and this can sometimes be misleading when used with those who use the term more generically.

The term '*fit*' is used very much in the same way as 'seizure' (i.e., to denote a variety of epileptic and non-epileptic events) – it is best avoided.

The term '*convulsion*' is usually used to denote seizures (or fits), in which there is prominent motor activity (such as bilateral stiffening, repetitive jerking of the limbs or thrashing movements). Convulsions can be epileptic or non-epileptic.

The terms *grand mal* (literally big attack) and *petit mal* (small attack) were introduced in the 19th century and should no longer be used. They are obsolete principally because there are multiple seizure types that might be referred to as grand mal or petit mal and they have become non-specific undefined terms

Of the terms indicated **it is best to only use 'seizure' and 'epileptic seizure' and possibly also 'convulsion', but always remembering that in practice neither 'seizure' or 'convulsion' necessarily imply an epileptic basis.**

2.4 Epileptic Seizures – What are they?

Task 2:

In Task 1, a distinction was made between *epileptic* and *non-epileptic seizures*. We will now consider what we mean by this distinction. Imagine that on the same day two 12-year-old girls are admitted to the same hospital. Both had been walking to school when they had collapsed to the ground, had gone stiff and had some jerks of their limbs. After a full history had been taken, a medical examination performed and some tests undertaken, one of the girls was diagnosed as having had a probable epileptic seizure, whilst the other was diagnosed as having had a syncopal event (or 'faint'- an example of a non-epileptic seizure). What is the crucial difference underlying this distinction?

Commentary 2:

The crucial difference is that **by diagnosing an epileptic seizure one is implying that the event has occurred as a direct consequence of epileptic activity in the brain** rather than as a consequence of some other mechanism. Note that the outward manifestations of epileptic and non-epileptic seizures may be identical. What is important, in terms of whether they are epileptic or non-epileptic, is the mechanism giving rise to them. Non-epileptic seizures might arise as a consequence of some other disturbance (non-epileptic) of brain activity or else as a consequence of problems outside the brain (for example in the heart).

Of course, by saying that epileptic seizures arise as a consequence of epileptic activity in the brain, one could be accused of simply deflecting the question. What is 'epileptic activity'? A feature of certain brain cells (neurones) is that they are excitable. That is, they can generate and transmit electrical signals. It is disturbances in this that we call epileptic activity. Loosely speaking *epileptic activity* can be considered as a disturbance in the electrical activity of the brain. Stated more scientifically **epileptic activity involves the excessive and/or hypersynchronous discharge of neurones.**

Hence the full definition of an epileptic seizure is:
A transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal activity in the brain.

This is the definition given by the International League Against Epilepsy (ILAE). The ILAE is recognised, throughout the world, as the main authority on the use of terminology and classifications in clinical epileptology.

2.5 Epileptic Seizures – what happens during them?

Task 3:

The table below lists a whole lot of features that may occur during seizures (epileptic or otherwise). Indicate which you consider might be a manifestation of epileptic activity (i.e. part of an epileptic seizure).		
Feature	*Might be a manifestation of epileptic seizure*	*Not a manifestation of an epileptic seizure*
Sudden fall		
Jerking of limbs		
Blank stare		
Urinary incontinence		
Perceiving a funny smell		
Feeling of fear		
Thrashing movements of limbs		
Facial flushing		
Seeing coloured spots		
Vomiting		
Racing heart		
Tingling sensations		
Headache		
Generalised stiffening		
Floppiness		
Feeling of unfamiliarity		
Ringing noises		
Hiccups		
Sudden loss of vision		

Commentary 3:

This was a bit of a trick question. All of the features may be manifestations of epileptic seizures. Remember, **the brain controls the rest of the body, and consequently just about everything imaginable may be a manifestation of epileptic activity**. This may make you think that the task of deciding whether something is likely to be epileptic or not is hopelessly difficult. This is not the case as we shall see later. The point to note at this stage is that there are numerous manifestations of epileptic seizures.

Given the protean manifestations that may occur during epileptic seizures, some order is needed. Hence, we classify epileptic seizures into different types. Many different classifications have been devised. **Most modern classifications divide epileptic seizures into *generalised* onset and *focal onset epileptic seizures***. The term focal is synonymous with, but now preferred to, *partial*.

Task 4:

Have a go at trying to define generalised onset and focal onset epileptic seizures:	
(i) Generalised onset epileptic seizure	
(ii) Focal onset epileptic seizure	

Commentary 4:

The ILAE gives the following definitions:
Generalised onset epileptic seizures: ***Are conceptualized as originating at some point within, and rapidly engaging, bilaterally distributed networks. Such bilateral networks can include cortical and subcortical structures, but not necessarily include the entire cortex.***

Focal onset epileptic seizures: ***Are conceptualized as originating within networks limited to one hemisphere. These may be discretely localized or more widely distributed***

(Going forward in this workbook these seizure types will be referred to as generalised and focal epileptic seizures)

Put more simply, focal epileptic seizures **start** from a localised area of the brain; generalised epileptic seizures appear to **start** from both sides of the brain simultaneously. The word 'start' is in bold to emphasise that if a seizure starts from a localised part of the brain but then spreads to both sides of the brain, it is still classified as focal. However, in order to indicate the sequence, it can be called a **focal to bilateral tonic-clonic seizure** (historically referred to as secondary or secondarily generalised seizures).

2.6 Generalised onset epileptic seizures

There are about a dozen generalised epileptic seizure types recognised by the ILAE. They are diverse in their manifestations. The most commonly encountered generalised epileptic seizures are the following:

- Generalised tonic clonic seizures (GTCS)
- Tonic seizures
- Myoclonic seizures
- Atonic seizures
- Absence seizures

Task 5:

GTCS constitute what the lay person is likely to consider as an epileptic seizure. Write down what you consider to be 3 key features of a GTCS.	
1.	
2.	
3.	

Commentary 5:

GTCS have two main components, the tonic phase and the clonic phase. During the tonic phase the child will go stiff (the meaning of tonic). Simultaneously they may let out a cry (sound) and will lose awareness, falling to the ground. After a variable period, the second or clonic phase will begin. It is characterised by rhythmic jerking of the limbs. Note that not all movements during epileptic seizures are clonic – only those involving rhythmical jerking of the limbs. During GTCS many other features may be observed, particularly autonomic features, such as breathing irregularities, colour changes (including cyanosis) and urinary (and occasionally faecal) incontinence. The clonic phase typically begins as a fast low amplitude jerking and gradually becomes slower and larger jerking before it subsides, usually within two minutes or so. Once the seizure stops, the child is likely to be drowsy and often goes to sleep. This is known as the post ictal phase. It may be quite short, lasting a matter of minutes, but can be prolonged for many minutes, or even longer, up to 1-2 hours.

Tonic seizures are characterised by an increase in tone, which is bilateral but may be of the whole body or just the neck and can be subtle (eg causing retropulsion of the head). The duration of stiffness is longer than 3 seconds. *Atonic seizures* involve a loss of postural tone, again this may involve the entire body causing the child to fall to the ground or quite subtle of only the neck (e.g. causing a head nod). *Myoclonic seizures* (jerks) are characterised by sudden shock like (typically lasting milliseconds contractions of muscles, or groups of muscles and may be single or repetitive, rhythmical or arrhythmical.

Task 6:

Write down what you think is meant by the term '*absence seizure*'.

Commentary 6:

In absence seizures the main manifestation is an impairment of awareness. The child may stare blankly ahead and be unresponsive. In some absence seizures other things may happen, for example, the child may fumble with their hands or smack their lips, or their eyelids may flicker. However, these features are usually less prominent than the impaired awareness.

There are different types of absences. *Typical absences* start and end abruptly (like a light going off and then coming on again), with the child resuming their normal activities immediately. In *atypical absences* (a different seizure type, which occurs within some epilepsy syndromes, for example *Lennox-Gastaut syndrome*) the start and finish is usually less abrupt, such that the child appears to drift into and drift out of the atypical absence.
In practice, EEG is needed to confirm seizures are absences as there are other types of epileptic and non-epileptic seizures that have 'unresponsive stares' as a feature. The term 'absence' strictly refers to a generalised seizure type with specific EEG changes. The term 'absence' should not be loosely used for any seizure in which impairment of awareness is a feature. For example, focal seizures, especially some arising in the temporal lobes can have altered awareness or responsiveness as the only feature. This change in awareness is sometimes referred to as a dyscognitive feature. For clarity the term absence should be avoided unless specifically referring to a seizure which is generalised in onset.

2.7 Focal onset epileptic seizures

The clinical manifestations of focal epileptic seizures depend both on where the seizure starts and where it spreads to.

Until recently focal epileptic seizures were mainly divided into those in which there was impairment of awareness (these were previously called complex focal, complex partial seizures or dyscognitive seizures) and those in which awareness was retained (these were known as simple focal or simple partial seizures).

Focal seizures are now classified as those:

(i) With motor or non-motor onset components (e.g. sensory, autonomic, behaviour arrest, cognitive, emotional)

(ii) With awareness or impaired awareness (previously termed complex partial seizures)

(iii) According to where in the brain they are likely to be arising from. Hence frontal lobe seizures, temporal lobe seizures, parietal lobe seizures and occipital lobe seizures.

2.8 Epilepsy and the Epilepsies

So far, we have been considering different types of epileptic seizures. Epileptic seizures are essentially symptoms, rather than diseases in their own right. A useful analogy is to think about the respiratory system. Cough is an important symptom of respiratory diseases. There are different types of cough, such as dry cough, barking cough and productive cough. Although each of these different types of coughs tells you something about the person's condition, they do not define individual diseases. A productive cough can be a symptom of a cold, pneumonia or tuberculosis.

Thus, it is with epileptic seizures. They are symptoms of a whole host of different disorders, which we call epilepsy. Although it is conventional to talk about 'epilepsy', it is important to remember that there is no single entity called epilepsy. Rather the term epilepsy is used to denote a group of heterogeneous disorders in which epileptic seizures occur. **It is better practice to think of 'the epilepsies' rather than 'epilepsy'.**

Task 8:

How might you, in simple terms, define *epilepsy*?

Commentary 8:
The ILAE in 2005 gave the following definition of epilepsy:
Epilepsy is a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures, and by the neurobiological, cognitive, psychological, and social consequences of this condition. The definition of epilepsy requires the occurrence of at least one epileptic seizure.

The ILAE in 2014 proposed a new operational definition:

Epilepsy is a disease of the brain defined by any of the following conditions:
1. At least two unprovoked (or reflex) seizures occurring >24 h apart
2. One unprovoked (or reflex) seizure and a probability of further seizures similar to the general recurrence risk (at least 60%) after two unprovoked seizures, occurring over the next 10 years
3. Diagnosis of an epilepsy syndrome

The important point is that epilepsy generally involves **RECURRENT** epileptic seizures.

Epilepsy is not necessarily life-long. Many children and young people with epilepsy only have epileptic seizures for a matter of months.

The epileptic seizures, however, do not only occur during some temporary and reversible upset. For example, patients with disturbances of their biochemical or water balance may have 'epileptic seizures'. However, once the biochemical or water imbalance is corrected the seizures will stop. These patients are not considered to have epilepsy. Seizures that arise in the context of temporary, potentially reversible disorders are often called 'acute symptomatic seizures. Similarly, young children may have epileptic seizures provoked by fever. Epileptic seizures occurring during a febrile event, not caused by an acute disease of the nervous system, in a child aged 6 months to 5 years, with no neurologic deficits are called febrile seizures and are not considered epilepsy. These are discussed in more detail later.
Some types of epilepsy are called *epilepsy syndromes (sometimes referred to as electroclinical syndromes)*. The ILAE defines an epilepsy syndrome as:

"A complex of signs and symptoms that define a unique epilepsy condition with different aetiologies"

In other words, epilepsy syndrome is a recognisable and characteristic pattern of age of onset, history, examination, seizure type(s) and EEG features. However, the underlying cause of the epilepsy for one child with a particular epilepsy syndrome is not necessarily the same as another child with the same epilepsy syndrome.

2.9 Epidemiology

Up to **5% of people will have at least one epileptic seizure in their life.** Of course, not all of these will have recurrent seizures (epilepsy).

- The incidence of epilepsy is the number of new people diagnosed annually.
- The prevalence of epilepsy is the number of people with epilepsy at any given time.

Incidence rates vary depending on the definition of epilepsy used and on the age of the population studied. In developed countries the *incidence of epilepsy* is around 150 per 100,000 in the first year of life, 60 per 100,000 in mid-childhood and 45-50 per 100,000 in later childhood.

The *prevalence of epilepsy* in children and young people is about 0.5% (1 in 200 may be easier to remember). For example, in a medium sized UK city like Sunderland, with a total population of 300,000, of which 85,000 are 0-16 years, one would expect there to be about 400 children and young people with epilepsy at any one time.

2.10 What types of epilepsy are there?

A person with epilepsy is best described in an ongoing multi-axial format according to ILAE classification with:

- The accurate description of their seizures
- Their types of seizures (generalised or focal)
- Whether they fulfil criteria for an epilepsy syndrome
- Any identified underlying cause(s)
- Associated co-morbidities and learning problems

BPNA PET courses have developed the DESSCRIBE approach as a pragmatic multiaxial approach. This approach will be introduced and developed throughout the PET courses.

For some children and young people with epilepsy the underlying cause for the epilepsy can be determined. The cause can be a structural, metabolic, infectious, immune and/or a genetic cause. Sometimes the cause is unknown or a combination of the above.

Epilepsy sometimes occurs when an underlying disorder is strongly suspected (e.g. because the child has intellectual disability or severe behavioural problems predating the onset of epileptic seizures), but even after appropriate investigations have been undertaken, no cause can be found. These epilepsies used to be referred to as *probably symptomatic epilepsy* or '*cryptogenic epilepsy.*'

The term idiopathic epilepsies has fallen in and out of favour within ILAE classification systems. It has been traditionally used for those epilepsies which were presumed to be genetic in origin and are often age-related. The term created some concern that it encouraged assumptions to be made about a child's diagnosis, intellectual ability or genetic basis that might not be valid. For example, the child had a proven genetic cause for epilepsy or was unlikely to have intellectual disability. It is currently suggested as a term that is useful when referring to the following specific epilepsy syndromes: Childhood absence epilepsy, juvenile absence epilepsy, juvenile myoclonic epilepsy, epilepsy with generalised tonic clonic seizures alone.

Task 10:

Write down 5 disorders that you consider may lead to epilepsy as a secondary problem.	
1.	
2.	
3.	
4.	
5.	

Commentary 10:

You could have chosen any of the following examples:

Brain malformations and maldevelopments

Neurocutaneous disorders (such as tuberous sclerosis)

Post head injury

Post infection (congenital viral infections, meningitis, encephalitis)

Post hypoxic-ischaemic insults (such as birth asphyxia)

Brain tumours

Vascular malformations

Chromosomal abnormalities

Metabolic disorders

2.11 Febrile Seizures

Febrile seziures is a specific disorder where children between the ages of 6 months and 6 years have a genetic predisposition to have seizures with fever.
By convention epileptic seizures, even if recurrent, which are provoked by and only occur during a temporary disturbance such as a high or low blood sodium level or low blood sugar level are not considered to be a manifestation of epilepsy. It is important to note that, despite this, the seizures are still epileptic in origin. By far the commonest example is febrile seizures.

. In febrile seizures the seizures are triggered by fever but are not caused by fever Most febrile seizures are GTCS. However, fever can provoke other types of epileptic seizures such as generalised clonic seizures, atonic seizures and unilateral seizures (hemiconvulsions). It is also worth remembering that fever can also provoke non-epileptic events , such as rigors and faints.

Febrile seizures are conventionally classified as being simple (70%) or complex (30%).

Simple febrile seizures are: generalised (i.e. without focal features), short (last under 10 minutes – some say under 15 minutes) and do not recur within 24 hours, or within the same febrile illness. Complex febrile seizures have focal features, or last more than 10 minutes (some say more than 15 minutes), or recur within 24 hours or during the same febrile illness.

A febrile seizure can be complex because of 1, 2 or 3 of the listed features. Although it is accepted that simple febrile seizures can last 10 (or 15 minutes), in practice, most are much shorter (under 2 minutes). Febrile seizures lasting more than 5 minutes constitute febrile ‘status epilepticus’ – a medical emergency.

Task 11:

Test your current knowledge of febrile seizures by answering the following questions.	
1.	How young can a child be when they have their first febrile seizure?
2.	To what age can a child continue to have febrile seizures?
3.	How high does the temperature have to be before a febrile seizure can be diagnosed?
4.	Does meningitis cause febrile seizures?
5.	Do febrile seizures run in families?

Commentary 11: The 2018 NICE guidelines have defined a febrile seizure as:

"A febrile seizure is generally accepted to be **a seizure accompanied by fever** (temperature **more than 38°C** or 100.4°F by any method), **without central nervous system infection**, which occurs in infants and children aged **6 months up to 6 years**."

Other definitions exist but this one is pretty standard, others express the age range slightly differently. To diagnose a febrile seizure under the age of 6 months would be exceptional (and should only be done after the most thorough exclusion of other causes) and very few children will present with a first febrile seizure after the age of 6 years. The peak incidence for the first febrile seizure is from 9 to 20 months.

In practice a recorded or assumed temperature of 38°C is usually accepted as the lower limit.

By definition, febrile seizures are only diagnosed if there is no other cause for the seizure other than the fever. This means that if a seizure occurs in a child who is febrile as a consequence of meningitis, the seizure is not considered to be a febrile seizure. However, it is very important to note that children, particularly young children, with meningitis may have seizures that are indistinguishable from febrile seizures. The definition means that children and young people with other neurological conditions, for example cerebral palsy, who have seizures when febrile should not be diagnosed with febrile seizures.

There is a strong genetic basis for febrile seizures, as indicated by the fact that risk to siblings if one child has had a febrile seizure is about 25% and that there is a high concordance in monozygotic twins. Most authorities consider the inheritance to be polygenic (that is due to the effect of multiple genes), although autosomal dominant inheritance has also been recognised. Recently, linkage to a number of chromosomes has been found in families with febrile seizures, and some children with febrile seizures have been shown to have mutations in specific genes.

Task 12:

You are counselling the mother of a child who has just been diagnosed as having had a febrile seizure. She asks you the following four questions. For each, indicate how you would reply.	
1.	I have never heard of febrile seizure before; are they very rare?
2.	What is the chance that it will happen again?
3.	How dangerous are they?
4.	Does it mean my child will probably develop epilepsy?

Commentary 12:

By 6 years, 3-4% children will have had 1 or more febrile seizures. Therefore, they are common. Boys are affected more often than girls and black children more often than white children.

The overall risk of recurrence is 30-40%. The main predictors of risk are: early age of onset; family history of febrile seizures; duration of illness; and lower temperature at time of seizure. The earlier the age of onset, the greater is the risk of recurrence. Children with a first febrile seizure before one year of age have a 50% chance of recurrence, compared with 20% if the first seizure is after age 3 years. Risk factors can be combined to provide a useful prediction scheme. The recurrence risk for those with none of the four risk factors (age less than 18 months, family history of febrile seizures, low temperature at the time of the seizure and short duration of illness) is 4%, with one factor 23%, with two 32%, with three 62%, and with all four 76%.

Families of children with febrile seizures can be reassured that, with the exception of the risk of injury, short febrile seizures are not dangerous. However, febrile seizures lasting over 30 minutes (febrile status epilepticus) can have an appreciable morbidity and mortality. This is largely because febrile status epilepticus may be the presentation of an acute disorder such as meningitis or related to a pre-existing underlying neurological disorder.

Moreover, in most cases febrile seizure will not be followed by epilepsy. However, the risk of the latter is increased compared to the normal population approximately six fold by 24 years of age. Risk factors for this are: abnormal neurological or developmental status prior to first febrile seizure (although it is questionable if these should be considered febrile seizures); family history of afebrile seizures; complex febrile seizure. Complex febrile seizures are where the seizure is prolonged, focal or recurrent in the same illness. The risk of epilepsy increases the more risk factors there are. For example, if there is a single risk factor, the risk is 6-8% but if all three factors are present it is almost 50%. If epilepsy does develop it can take many different forms.

2.12 Misdiagnosis of Epilepsy

The misdiagnosis rate of epilepsy is high. Children and young people are both diagnosed with epilepsy when they do not have epilepsy and, conversely children and young people who have epilepsy are left without appropriate diagnosis. Some studies have suggested that in certain settings **up to a third of children and young people diagnosed with epilepsy may not have it.**

Task 13:

Can you think of some reasons why misdiagnosis of epilepsy is high?

Commentary 13:

Among the more important reasons you could have mentioned:

- In order to make the diagnosis the clinician is usually reliant on descriptions of the events; only rarely will they witness them for themself. Such descriptions are likely to be incomplete and inaccurate.
- The clinical events which occur during epileptic seizures often correspond very closely to those which occur during non-epileptic seizures.
- There is no laboratory test for epilepsy, in the way that there is for many other disorders. Although anEEG is an important investigation in people with epilepsy as it helps define the type of epilepsy it does not make a diagnosis of epilepsy. It lacks both sensitivity and specificity to do that. It is liable to misinterpretation. We will look at this in a later section.

2.13 Paroxysmal Non-epileptic Disorders

There are numerous disorders in which paroxysmal (sudden; unexpected, out-of-the-blue) events occur which may mimic or be confused with epileptic seizures. Among the more common and/or important of these are:

- Syncopes and anoxic seizures, including cardiac disorders
  - Reflex anoxic seizures
  - Breath holdingspells
  - Simple faints (vasovagal syncope)
  - Long QT disorders (which predispose to dangerous cardiac arrhythmias)
  - Other cardiac syncopes
  - Suffocation
- Behavioural events and psychological disorders
  - Daydreams and childhood preoccupation / poor ability to concentrate
  - Self-gratification / masturbation
  - Ticks and stereotypies
  - Functional seizures
- Sleep disorders
  - Nightmares
  - Night-terrors
  - Narcolepsy - cataplexy

- Paroxysmal movement disorders
  - Non-epileptic myoclonus, including benign neonatal sleep myoclonus
  - Dyskinesias
  - Paroxysmal ataxias

During PET you will have the opportunity to view video examples of many of these and do case studies of common syncopes. For now, it is worth making a few general points:

1. A syncope or faint is a paroxysmal event caused by a sudden, temporary decrease in the supply of oxygenated blood to the brain, either from a reduction in the blood flow itself, or from a drop in the oxygen concentration in the blood, or a combination of both. Syncope is manifested as a loss of awareness, often accompanied by a loss of postural tone sometimes followed by stiffening of the body, jerks, etc. The term anoxic seizure is often used synonymously with syncope, especially if stiffening of the body, jerks, etc. are prominent.

2. Syncopes can be very easily confused with GTCS and some other types of epileptic seizures.

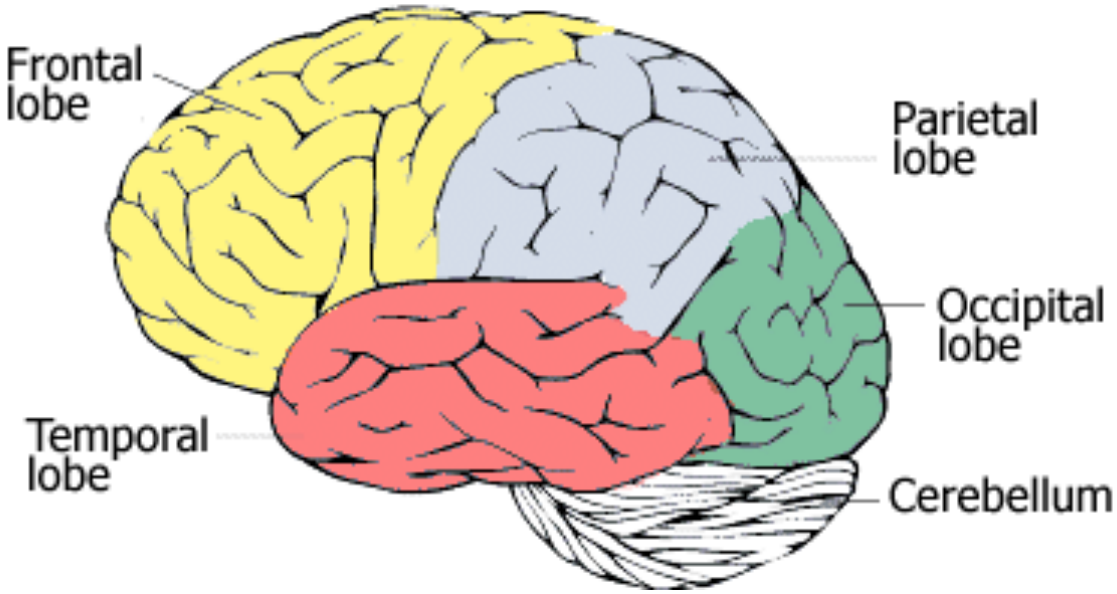
3. There are no single features that reliably distinguish syncopes from epileptic seizures. It is a mistake to rely on features such as the occurrence of urinary incontinence, tongue biting, body jerking etc. However, it is usually possible to distinguish between them if a detailed account of all the events that occurred during the event and the circumstances in which the event occurred is obtained.

2.14 Additional Information

How it possible to work out those parts of the brain which are likely to be involved in a focal epileptic seizure?

Task 14:

The picture of the brain below is annotated to show its component lobes and alongside these are indicated the principle functions of each lobe.



Frontal lobes – major part of the brain controlling movements. Also involved in many higher intellectual functions

Temporal lobes – involved in functions such as emotion and memory. Also involved in the perception of smell and taste and in hearing

Parietal lobes – involved in the perception of 'ordinary' sensations (light touch, pain, etc.)

Occipital lobes – involved in the perception of visual stimuli

The following are brief descriptions of seizures given by, or seen in, children and young people. Indicate, in the table below how the seizures might be classified, by placing a tick in the appropriate box. More than one box may be ticked.

Seizure	*Focal motor onset seizure*	*Focal sensory onset seizure*	*Frontal lobe seizure*	*Temporal lobe seizure*	*Parietal lobe seizure*	*Occipital lobe seizure*
1. I start to feel funny. It's horrible and I am afraid. Sometimes I get a horrible taste in my mouth.						
2. It happens at night. He seems to wake up and then have difficulties with his arm and leg. I think the left becomes stiff. Sometimes he makes funny noises. He isn't with it. It's over quickly – after 20 seconds maybe – and then he falls asleep again.						
3. I see blobs of colours, green and red and sometimes purple. They move around a bit but are often at the edge of my vision. I often get a headache. Last time, everything went black – I couldn't see anything. It was very scary.						
4. It starts in my left hand. My fingers twitch. Then my arm starts to go as well and sometimes my face twitches as well.						

Commentary 14:

The first seizure is manifested with fear and unpleasant olfactory hallucinations. These are sensory symptoms (hence it could be classified as a focal sensory seizure) and are often described in patients with temporal lobe seizures.

The second seizure is manifested by the onset of motor symptoms involving tonic posturing of limbs. The funny noises are likely to be a manifestation of involvement of the pharyngeal and/or laryngeal muscles. Hence this is a focal motor onset seizure. It is probably arising in the right frontal lobe.

The third seizure is manifested by visual hallucinations and by blindness. These are sensory symptoms; hence this is a focal sensory onset seizure. It is likely to arise in the occipital lobes. Headache is common in occipital lobe seizures.

The fourth seizure is manifested as clonic jerking of an upper limb / face. It is clearly a focal motor onset seizure. It is likely to arise in the primary motor cortex of the right frontal lobe.

3. INVESTIGATIONS

3.1 Introduction

In this section you will explore the uses and abuses of investigations in the diagnosis and management of children and young people with epilepsy or suspected epilepsy.

3.2 Learning Objectives

By the end of this section you should:

- Be able to list those investigations which are appropriate when a child newly presents with a seizure.
- Know when it is appropriate to request an EEG.
- Be able to explain the significance of epileptiform and non-epileptiform EEG abnormalities.
- Be able to explain the role of CT and MRI brain scans in investigating children and young people with epileptic seizures.
- Be able to describe when other investigations may be useful.

3.3 The EEG

What is an EEG?

An *EEG* is an investigation in which the electrical activity of the brain is recorded. The activity of neurones generates differences in potential between different parts of the brain. These differences can be detected using electrodes. In most EEG recordings an array of 20 electrodes are used. These are painlessly attached to the scalp usually using paste or a type of glue. This is known as a scalp EEG.

In the past EEGs were recorded onto paper. Now most are recorded digitally and displayed on VDU screens. Most EEGs are done as an out-patient procedure with the patient mostly awake although sleep can add value. The EEG is usually recorded for between 20 and 40 minutes and includes synchronised video of the child. EEGs routinely include 'provocations of hyperventilation and photic stimulation. In the UK children do not have any special requirements prior to the EEG. These EEGs are called *routine or standard EEGs*. There are a number of special types of EEG. The most common is the *sleep EEG* which as its name suggests is recorded in sleep. Sleep can be ascertained by either sleep deprivation prior to the EEG (a sleep deprived EEG) or by medication (sedated EEG).

Because epileptic seizures usually only happen occasionally, most EEGs are recorded between seizures (*interictal EEG*). Occasionallya seizure occurs while the EEG is being recorded (*ictal EEG*). This most often occurs with absence seizures which can be triggered by hyperventilation or myoclonic seizures which can be triggered by photic stimulation but can occur rarely by chance or due to the sleep deprivation.

What can the EEG do?

Task 1:

Which of the following statements do you think are true?		
		True/False
1.	An abnormal EEG confirms the diagnosis of epilepsy.	
2.	The EEG is a useful test to do if a child's seizure is probably non-epileptic but could just possibly be epileptic.	
3.	If an EEG is negative it makes epilepsy unlikely.	

Commentary 1:

You should have answered false to all the questions.

The EEG is an extremely useful test in the investigation of children and young people with epilepsy as it helps define the type of epilepsy the child has. However, misuse of it, particularly as a tool to rule out or rule in epilepsy, is one of the main reasons why there is a high rate of misdiagnosis.

Any EEG recording consists of the background activity and paroxysmal activity. The former is the on-going electrical activity of the brain. The latter is any burst of EEG activity that stands out as different from the background activity. A normal EEG consists of both normal background activity and normal paroxysmal activity. An EEG can be abnormal either because it contains abnormal background activity or because it contains abnormal paroxysmal activity. However, **only some EEG abnormalities are found in people with epilepsy**. Some abnormal paroxysmal activity is associated with a much-increased risk of recurrent seizures. Such paroxysmal activity is called *epileptiform activity*. **In general, it is only epileptiform activity that is found in people with epilepsy**. Abnormal background activity and non-epileptiform paroxysmal activity does not, rule in or rule out a diagnosis of epilepsy.

Anyone who requests an EEG should remember 2 key points:

1. **Even in people with definite epilepsy a single EEG recording is likely to be normal in about 40-50% of cases (i.e. the EEG lacks sensitivity for making a diagnosis of epilepsy).**

2. **Abnormal EEGs are common in people who do not have and never will have epilepsy. About 5% of healthy children and young people (i.e. who do not have epilepsy) will have epileptiform EEG abnormalities on their EEG (i.e. the EEG lacks specificity for making a diagnosis of epilepsy).**

It follows from these facts that the EEG cannot usually be used to either confirm or refute the diagnosis of epilepsy.

Task 2:

We have already considered whether the EEG can help to diagnose epilepsy and that in this regard it has significant limitations. Can you think of any purposes for which the EEG might be useful when investigating a child with epilepsy or suspected epilepsy? [Hint – if you can think of two, you are doing well!]	
1.	
2.	

Commentary 2:

You might have suggested one or more of the following:

(i) Helping to determine the type of epilepsy

(ii) Helping to determine if seizures are precipitated by photic (light) factors

(iii) Helping to decide the child's prognosis

(iv) Helping to decide what drug treatment is the most appropriate

(v) Helping to decide whether to continue or discontinue anti seizure medication

As we have already seen, there are many different types of epilepsy.

Epilepsy types are determed by the types of seizures, other clinical features and what is found on the EEG. Because knowing the type of epilepsy is essential in determining whether or not totreat a particular patient,and, if so, what drug to use, **the EEG is an important investigation in people with epilepsy.**

A small number of children and young people with epilepsy (probably about 5%) have seizures which are precipitated by photic (light) factors, such as TV programmes, video-games and discos. This *photosensitivity* can be reliably detected using photic stimulation during the EEG recording. **Therefore, the EEG can help decide if a person's seizures are likely to be provoked by flashing lights, etc.**

It seems common sense that the EEG should be helpful in deciding how long anti seizure medication should be continued. Unfortunately, in general, it is far too insensitive for this, but there are some exceptions.

What 2022 NICE says about using the EEG

1.2.5 If the person's history and examination suggest an epileptic seizure, and a diagnosis of epilepsy is suspected, consider a routine EEG carried out while awake to support diagnosis and provide information about seizure type or epilepsy syndrome.

1.2.6 Do not use EEG to exclude a diagnosis of epilepsy.

1.2.7 If an EEG is requested after a first seizure, perform it as soon as possible (ideally within 72 hours after the seizure).

1.2.8 When offering an EEG, discuss the benefits and risks of provoking manoeuvres during EEG, such as hyperventilation and photic stimulation, with the person and their family or carers if appropriate. If agreed, include provoking manoeuvres during routine EEG to assess a suspected first seizure.

1.2.9 If routine EEG is normal, consider a sleep-deprived EEG if agreed with the person, and their family or carers if appropriate, after discussing the benefits and risks.

1.2.10 If routine and sleep-deprived EEG results are normal and diagnostic uncertainty persists, consider ambulatory EEG (for up to 48 hours).

3.4 Brain Scans

CT or MRI?

MRI is the imaging investigation of choice for children and young people with some types of epilepsy. This because of the level of detail MRI shows of the brain structure and it also does not expose the child to ionising radiation as is the case with CT. A CT scan may be indicated in certain situations.

Task 3:

Can you think of one advantage of CT scanning compared to MRI scanning in investigating children and young people with seizures and vice versa?

Commentary 3:

In general, anything that is likely to be visible on CT scan will be visible on MRI scan and there are many things that are visible on MRI which are not visible on CT scan. (There are two exceptions to this: fresh blood and calcium are usually better seen on CT, unless special MRI sequences are used). This means that **MRI is nearly always preferred over CT when investigating children and young people with epilepsy.**

The major exception to this is when a child presents with a seizure in an acute context, particularly if he or she is not known to have seizures. If he or she recovers as expected, it is not usually necessary to obtain any form of brain scan urgently. However, if the child does not recover as expected, or if there are other worrying features, then a brain scan should be obtained. **In the acute situation the imaging method of choice is CT** because:

(i) *Intracranial bleeding* is usually an important consideration and is better detected by CT than MRI.

(ii) It is generally much more readily available.

Another consideration, particularly in younger children is that it is often possible to obtain a CT scan without sedation or an anaesthetic whilst this may be needed for an MRI scan. Some children and young people with a developmental age of under 7 years will not lie still for an MRI scan without either sedation or an anaesthetic. However, it should be noted that babies will often lie still if they are fed, wrapped and allowed to fall asleep.

Task 4:

Can you think of the sort of things a MRI brain scan might show in…	
a)	A child with an epilepsy where neuroimaging is not typically indicated (for example childhood absence epilepsy, juvenile absence epilepsy, juvenile myoclonic epilepsy)?
b)	A child with epilepsy secondary to a structural cause?

Commentary 4:

(a) This is of course a trick question. By definition **you would not expect there to be any scan abnormalities in these children and young people.** However incidental non-significant findings are common.

(b) These epilepsies can be associated with a large number of different abnormalities on MRI scans. These include:

(i) Old brain injuries following hypoxic-ischaemia, infections, etc.

(ii) *Malformations* and *maldevelopments* of the brain, such as agenesis of the corpus callosum, generalised neuronal migration defects and focal neuronal migration defects. One can also include here the lesions associated with disorders such as tuberous sclerosis and Sturge Weber syndrome.

(iii) Vascular malformations, such as arteriovenous malformations and cavernous angiomas.

(iv) Brain tumours, particularly slow growing tumours such as gliomas.

(v) *Mesial temporal sclerosis* which is a sclerotic ('scar-type') lesion affecting the medial part of the one or other *temporal lobes* and is commonly seen in children, young people and adults with temporal lobe seizures.

This list is not exhaustive. In many people with epilepsy, particularly if long-standing, non-specific abnormalities, such as diffuse brain *atrophy* will be seen.

Should all children and young people with epilepsy have a scan?

There is a fairly broad consensus as to when scanning is appropriate. This is reflected in the NICE guidelines shown below. Rather than say who should be scanned, it is perhaps easier to state that all children and young people with epilepsy should be scanned unless they are diagnosed as having certain epilepsy syndromes (*juvenile absence epilepsy, juvenile myoclonic epilepsy, childhood absence epilepsy, Epilepsy with Generalised tonic-clonic seizures only, self limited epilepsy with centrotemporal spikes*). *i.e.* those that used to be referred to as 'idiopathic generalised' or 'benign focal' epilepsies.

It should be noted that even if the child is diagnosed with one of these epilepsy syndromes, an MRI scan should be considered if seizures behave uncharacteristically or continue in spite of first-line medication.

What 2022 NICE says about Neuroimaging

Initial imaging scans
1.3.1 Offer an MRI scan to children, young people and adults diagnosed with epilepsy, unless they have idiopathic generalised epilepsy or self-limited epilepsy with centrotemporal spikes. The MRI should be carried out:

within 6 weeks of the MRI referral **and**

following regionally agreed epilepsy MRI protocols.

1.3.2 If MRI is contraindicated, consider a CT scan for children, young people and adults with epilepsy.

1.3.3 When offering an MRI or CT scan, discuss the risks and benefits with the person with epilepsy (and their families and carers, as appropriate), especially if a general anaesthetic or sedation is needed for the scan.

Reporting and reviewing scans
1.3.4 Ensure that MRI scans are reported by a radiologist with expertise in paediatric or adult neuroradiology, as appropriate.

1.3.5 If seizures are ongoing despite treatment, and diagnosis remains unclear, consider an additional review of MRI scans by a specialist in paediatric or adult neuroradiology within a tertiary centre.

Repeat scanning
1.3.6 Consider an additional MRI scan for children, young people and adults with epilepsy, if:

the original scan was suboptimal

there are new features to their epilepsy

they have idiopathic generalised epilepsy or self-limited epilepsy with centrotemporal spikes that has not responded to first-line treatment

surgery is being considered.

Scanning in acute situations
1.3.7 Do not carry out a CT scan for people with established epilepsy presenting at an emergency department after a typical seizure, unless there are other concerns.

3.5 Other Tests

Other than an EEG there are no tests which all children and young people with epilepsy must have.

If, when first seen, the child is still convulsing or has persisting decreased consciousness then it is essential to exclude *hypoglycaemia* with a bedside estimation of the blood glucose followed by a laboratory measurement of a blood glucose. It is also good practice to exclude *hypocalcaemia* and *hypo/hypernatraemia* ina child where the clinical situation suggests these may be a cause of the seizure. Other investigations will be dictated by the clinical circumstances.

If the child has already stopped convulsing when first seen and is recovering as expected there are no default investigations that are always necessary.

If an underlying genetic or metabolic cause for a child's epilepsy is possible then appropriate *neurometabolic* and *genetic investigations* should be undertaken alongside the MRI. However, these are often determined by the other parameters or clinical features, not the epilepsy itself. None of them are usually urgent and, therefore, can be left to the specialist following referral.

One of the important differential diagnoses of epilepsy is *cardiac syncopes*. Features that might suggest a cardiac syncope include:

(i) Events in keeping with faints that don't have the typical postural or vasovagal triggers or are accompanied by heart symptoms such as palpitation.

(ii) Events during or shortly after exercise.

(iii) Family history of *cardiac arrhythmias* and/or sudden death.

In people where cardiac syncope is suspected, or there is uncertainty about cause, it is important to obtain a 12 lead ECG. SIGN (Scottish Intercollegiate Guidelines Network) goes further and states that all children with a convulsive seizure should have a 12 lead ECG and this is the approach we have aligned with in the PET courses. Syndromes associate with *prolonged QT interval* are particularly important to exclude. Therefore, the corrected QT interval on the ECG should be calculated. If there is still doubt a cardiac referral should be made.

What 2022 NICE says about other investigations

1.2.2 Evaluate people after a first suspected seizure with a 12-lead ECG to help identify cardiac-related conditions that could mimic an epileptic seizure.

1.2.3 Be aware that metabolic disturbance, including hypoglycaemia, can result in seizures.

3.6 Additional Information

What other types of EEG are there?

As was said previously, by far the commonest type of EEG recordings are so-called routine EEGs, but there are a number of other types:

- Sleep deprived and/or Sleep EEG recordings
  These are relatively short (ueg 30-60mins) EEG recordings, during which it is hoped the patient will fall asleep. In order to make sleep more likely the patient may be partially sleep deprived or melatonin may be used to induce sleep. Partial sleep deprivation might involve asking the child's parents to keep them up late the night before the recording and wakening them up early on the day of the recording. Sleep EEGs are usually interictal recordings and are usually done as an out-patient or day case procedure. They are useful because certain EEG abnormalities associated with epilepsy are more common in sleep-deprivation or sleep. In some places in the world a sleep deprived EEG is the first EEG performed (Australia, New Zealand, Canada etc.)

- Ambulatory EEG Recordings
  These are prolonged EEG recordings, usually lasting about 24-hours. The child has the electrodes applied as an out-patient. The data is recorded in a small box. The child is allowed home and carries on normal activities. The next day the electrodes are removed. The purpose of ambulatory EEG recordings is usually to capture one or more seizures (ictal recording). They are only worth doing if seizures are frequent such that there is a fair chance of one occurring during a 24-hour period.

- Video Telemetry
  These are also prolonged EEG recordings, often made over several days or even a week or more. They are usually done as an inpatient procedure. Some epilepsy services are now offering home video telemetry for certain patients where appropriate. Essentially both an EEG and a simultaneous video are recorded. The purpose is nearly always to record one or more seizures (ictal recording). Its major role is in the evaluation of children and young people for possible surgical treatment of their epilepsy. It is also sometimes used if there is diagnostic doubt as to the nature of a child's events.

  All these types of EEG recordings involve applying the electrodes to the scalp (scalp EEG). When children and young people are being investigated for epilepsy surgery the electrodes are occasionally applied directly onto the brain surface or implanted within the brain substance. These are known as surface or invasive EEG recordings. They require a neurosurgical operation and are only available in specialist epilepsy surgery centres.

If the EEG cannot be used to diagnose epilepsy, is it of no use if I am considering the diagnosis of epilepsy but am not sure?

If, on the basis of the clinical history, an epileptic basis for a child's seizures seems likely, the EEG will help determine the type of epilepsy. Even a normal EEG is useful to support the diagnosis of a particular type of epilepsy as some types of epilepsy are less likely to have epileptiform discharges on a 30 min EEG than others. However, if on the basis of the clinical history a child's events are likely to be non-epileptic, the finding of epileptiform EEG abnormalities may be highly misleading. The seizures could still be non-epileptic and the EEG abnormalities could be incidental.

The important take home message is:
If ,after the clinical assessment, it is determined the child has epileptic seizures they should have an EEG. If after that assessment the clinician does not think the child has epileptic seizures OR THEY ARE NOT SURE if the events are epileptic or not DO NOT DO AN EEG.

Besides CT and MRI scans are there any other types of brain scans used to investigate epilepsy?

In babies whose *fontanelles* are open, ultrasound brain scans can be done. However, these rarely show anything helpful in the diagnosis of epilepsy.

4. TREATMENT

4.1 Introduction

In this section you will consider when, why and how we treat children and young people with epilepsy with anti-seizure medication, including rescue medication. The place of important non-pharmacological treatments will also be looked at.

4.2 Learning Objectives

By the end of this section you will:

- Be able to explain the principles that determine whether or not to start anti-seizure medication.
- Be able to identify an appropriate anti-seizure medication for treating children and young people with newly presenting seizures.
- Be able to list important adverse effects of anti-seizure medication.
- Know how to monitor children and young people on anti-seizure medication.
- Be able to explain the place of the newer anti-seizure medication in treating children and young people with epilepsy.
- Know how and when to discontinue anti-seizure medication.
- Understand the role of rescue medication.
- Have an understanding of the role of non-pharmacological treatments for epilepsy

4.3 Why do we treat epileptic seizures?

This seemingly simple question is one of the most important in clinical epileptology.

Task 1:

The following have been suggested as reasons for starting anti seizure medication in children and young people with epilepsy. For each, indicate how important a consideration it is in relation to starting treatment	
a)	To prevent the child suffering unpleasant seizures. *Very important Important Not very important Unimportant*
b)	To improve the long term prognosis for seizure control. *Very important Important Not very important Unimportant*
c)	To prevent the child dying *Very important Important Not very important Unimportant*
d)	To improve the child's performance at school *Very important Important Not very important Unimportant*

Commentary 1:

Many epileptic seizures (for example, TCS and many *temporal lobe seizures*) are unpleasant, frightening and often embarrassing. During them there may be a risk of injury. Anti-seizure medication will prevent seizures in about 70-80% of cases. **Consequently, the prevention of unpleasant seizures is a major consideration when deciding whether to start anti-seizure medication.** However, because many children will not develop recurrent seizures (i.e. epilepsy) after a single seizure, **there are virtually no circumstances in which anti-seizure medication should be started after a single seizure in children (status epilepticus is sometimes an exception).**

For many decades most epileptologists considered that 'seizures beget seizures'. In other words that the more seizures one has had the more likely one is to have more. Population studies have shown that in most cases the prognosis for eventual remission is seizures is good and that this does not appear to be determined by whether or not the person has been treated with anti-seizure medication. This is why the term antiepileptic medication has been replaced by anti seizure medication. It is generally considered that **about 70-80% of people with recurrent epileptic seizures will become seizure free. Consequently, in the vast majority of cases the decision as to whether to start anti-seizure medication should not be based on the view that not to do so is likely to jeopardise the prospects of long-term seizure control.** An exception to this may be some rarer types of epilepsy (the *epileptic encephalopathies*) in which early control of seizures may improve the long-term prognosis.

The risk of premature death in people with epilepsy is 2-3 times higher than that of the general population. People with epilepsy die prematurely for a variety of reasons. Some of these relate to why they have developed seizures. For example, some patients with brain tumours will have seizures and will die prematurely from the tumour and some children and young people with *neurodegenerative diseases* develop seizures and die as a consequence of the neurodegenerative disease. Some people die as a direct result of seizures. For example they may drown in the bath whilst having a seizure, or fall from a height during a seizure. *Status epilepticus* can also directly lead to death.

In addition to these, people with epilepsy may die suddenly and unexpectedly. This is known as *SUDEP* (the full definition is that of a sudden, unexpected, witnessed or unwitnessed, non-traumatic and non-drowning death in patients with epilepsy with or without evidence of a seizure, and excluding documented status epilepticus, in which post-mortem examination does not reveal a toxicological or anatomical cause of death). SUDEP occurs most often in those with risk factors including young adults, those with uncontrolled convulsive seizures, nocturnal seizures and those with medication adherence issues.

Nevertheless, despite the increased mortality in epilepsy, the individual risk remains very low and must be balanced against the risks from anti seizure medication. **Overall, preventing death is not usually a consideration when deciding whether to treat with anti-seizure medication.**

Epilepsy can be associated with, in addition to epileptic seizures, cognitive and behavioural problems. However, these are by no means inevitable – many children and young people with quite frequent seizures have few, if any problems at school as a consequence. Nevertheless, there is evidence that in some children and young people, for example, those having absence seizures, anti-seizure medication can improve cognitive function and behaviour. Consequently, **improved school performance may be important when considering whether to start anti-seizure medication.**

To summarise, anti-seizure medications are usually started after considering fairly obvious issues over the short to medium term, rather than longer term considerations, such as eventual prognosis.

Task 2:

Indicate which management strategy you work towards in the following situations: [ASM = anti-seizure medication]	
a)	A child who has had two febrile seizures. *Regular ASM treatment* *No regular ASM treatment* *Unsure*
b)	A child who has had 3 GTCS at school. *Regular ASM treatment* *No regular ASM treatment* *Unsure*
c)	A child who has had 4 nocturnal seizures, characterised by tingling and twitching around one side of the mouth. *Regular ASM treatment* *No regular ASM treatment* *Unsure*
d)	A 6-year-old child who has been diagnosed with frequent typical absence seizures and who is falling behind with her reading. *Regular ASM treatment* *No regular ASM treatment* *Unsure*

Commentary 2:

(a) The vast majority of children with *febrile seizures* grow out of them without long-term harm. **Treatment of children with febrile seizures with regular anti-seizure medication is not considered appropriate.**

(b) **TCS are unpleasant and most authorities would recommend starting treatment after 2 or 3**, especially if they were occurring during the daytime.

(c) There are some childhood epilepsy syndromes which have an excellent prognosis, and which are manifested with seizures, which although recurrent, are often not particularly alarming or unpleasant. The most common example of this is *self limited epilespy with centro-temporal spikes (SeLECTS)* (previously called *rolandic epilepsy*). Seizures in this condition are often fairly 'mild' in their manifestations and usually occur in sleep. The use of anti-seizure medication needs to be carefully weighed up against the specific circumstances in the individual child, considering the potential impact of seizures and the potential adverse effects of medication.

(d) *Typical absences* in childhood absence epilepsy are 'mild' in their manifestations but usually occur very frequently (sometimes 100s a day). Although major cognitive problems are unusual, minor deterioration in schoolwork is very common and treatment is nearly always considered appropriate.

What NICE 2022 says about treatment

4.1.1 Develop an individualised antiseizure medication treatment strategy with the person, and their family and carers if appropriate, taking into account:
• sex
• age
• seizure type
• epilepsy syndrome
• whether treatment is needed
• risks and benefits of antiseizure medications, including their importance in reducing the risk of epilepsy-related death
• possible interactions with any other medicines taken
• any comorbidities
• the preferences of the person, and their family or carers if appropriate
• personal circumstances, such as education, employment, likelihood of pregnancy, driving, alcohol use, travel
• how and when antiseizure medicines need to be taken.
Epilepsies in children, young people and adults (NG217)

4.1.2 Take into account any particular issues for older people starting an antiseizure medication, especially those with comorbidities, for example:
• check for possible interactions with other medicines they are taking
• use a tailored approach to dosage and titration, usually starting at a lower dose and increasing slowly
• check if the person would benefit from an approach that takes into account multimorbidity; for more information, see NICE's guideline on multimorbidity.

4.1.3 Use a single antiseizure medication (monotherapy) to treat epilepsy whenever possible.

4.4 What drug should I use?

There is rarely a simple answer to this question. Anti-seizure medication differ in both their spectrums of activity and their adverse effect profiles. It is these that determine which anti-seizure medication is chosen in a given situation. Broadly speaking anti seizure medications have either a broad spectrum of activity against both generalised and focal seizure types or a narrow spectrum of activity.

Most children and young people requiring anti-seizure medication are started on either *carbamazepine*, *sodium valproate, levetiracetam or lamotrigine*. **Carbamazepine has a narrow spectrum of action, mainly being active against focal seizures** (including those evolving to bilateral convulsive seizures). **Sodium valproate has a broad spectrum of action against focal and generalised seizures**. However, there is mounting concern about the *teratogenic effects* on the fetus of sodium valproate. *Lamotrigine or levetiracetam*, newer drugs with a similar spectrum of efficacy to sodium valproate, are often preferred.

4.5 What are the options if initial treatment fails?

The chances of success are good – around 70-80% of children and young people will become seizure free.

Task 3:

List 3 reasons why a child started on anti-seizure medication might not become seizure free.	
1.	
2.	
3.	

Commentary 3:

You should have chosen from the following:

- The diagnosis may be wrong – the seizures may not have been epileptic after all – always review the diagnosis.
- The choice of anti-seizure medication may have been wrong for the type of epilepsy – for example, the child may have generalised seizures but has been started on carbamazepine.
- The medication may not have been prescribed appropriately – the dose may have been too low, or the medication may have been given too infrequently (e.g. once rather than twice a day).
- *Concomitant medications* may have been interacting with the drug to reduce its efficacy – always check if the child is taking other medications!
- The child may not be taking the drug as prescribed – adherence issues.
- The child may have a *drug resistant epilepsy.*

If having considered other possible reasons for failure, it is concluded that the child's epilepsy is genuinely resistant to the initial anti seizure medication, there are usually a number of options from which to choose. If the child has focal seizures, a drug with a narrow spectrum of action active against focal seizures or with a broad spectrum of action against focal and generalised seizures should be chosen. If the child has generalised seizures a drug with a broad spectrum of activity should be chosen.

4.6 What do I need to think about when using anti-seizure medications ?

The following are the major issues that clinicians need to consider when using anti-seizure medications .

I. **Adverse Effects**

Most children and young people have no adverse effects from anti-seizure medication. However, there are a huge number of potential adverse effects. It is impracticable to memorize these. Far more important is to **warn the parents of children and young people starting anti-seizure medications always to immediately report anything which causes them concern, particularly just after starting medication or following any adjustments.** A simple way of classifying the principle adverse effects of anti-seizure medications is:

(i) *Effects on the CNS* – anti seizure medication work in the brain and so it is not at all surprising that all of them can cause CNS side effects. To an extent these effects are predictable, often showing a relationship to the dose used. Problems include headache,

drowsiness, irritability, moodiness, hyperactive behaviour and many more besides. Some anti-seizure medications are more prone to causing CNS adverse effects than others. For example, drowsiness is quite often an initial problem with carbamazepine, whilst many parents complain that sodium valproate makes their younger children's behaviour worse. Levetiracetam can cause mental health issues such as mood or anxiety problems. Parents often worry that anti-seizure medications are likely to interfere with a child's learning abilities. However, psychological studies of the common anti-seizure medications have been very reassuring. Impaired learning abilities are generally only a problem caused by the drug if the drug causes the child to be drowsy.

(ii) *Idiosyncratic reactions* – These are effects which cannot be readily predicted and usually do not show a clear relationship to dose. Many of them are peculiar to particular drugs. Amongst the most common are rashes.

(iii) *Teratogenic effects* – The background risk of a major malformation in the newborn is around 2%. This is increased to 5-6% in those whose mothers received a single anti-seizure medication and to 10% if the mother took two anti-seizure medications. Dose is a factor. **All the established anti-seizure medications have teratogenic effects.** The risk is greatest with sodium valproate and topiramate. This has an additional major risk of causing subsequent learning difficulties in children born to mothers on sodium valproate and on topiramate Teratogenic effects for other anti-seizure medications are lower than for sodium valproate and topiramate.

II. Drug Interactions

Unfortunately most anti-seizure medications have important interactions to think about. Such interactions include:

(i) Interactions with other anti-seizure medications. This can lead to increases or decreases in the blood levels of anti seizure medications. In turn this can impair the effectiveness of the drug or lead to toxic side effects

(ii) Interactions with other drugs. Some anti-seizure medications cause the blood levels of other drugs to fall. The most important example of this is that **the efficacy of the contraceptive pill is reduced by a number (but not all) anti-seizure medications .** Any clinician starting or stopping an anti-seizure medication in a woman taking the contraceptive pill needs to consider this carefully. Some drugs can cause an increase or decrease in the levels of anti-seizure medications . One important example of this is that **erythromycin (a commonly prescribed antibiotic in children and young people) interacts with carbamazepine, often leading to carbamazepine toxicity.** Drug interactions must be considered when any changes (increase or decrease) are made to the dose of an anti-seizure

medication or when any drug is started or stopped in a child on an anti-seizure medication.

III. Blood tests

There is a common misconception that children and young people on anti-seizure medications require regular blood tests. In fact **most epileptologists manage children and young people with epilepsy with no or only very few blood tests.**

The data sheets of a number of commonly prescribed anti-seizure medications recommend *full blood counts*, *hepatic* and *renal function tests* prior to and following initiation of the drug. The aim of this is to detect potential adverse effects. However, the evidence that such tests are of practical value is lacking and the NICE guidelines on the management of the epilepsies in children and young people does not recommend them.

It is possible to measure the blood levels of a number of anti-seizure medications. For some, but not all anti-seizure medications, there is a correlation between the blood level and effectiveness. However, most children and young people dislike blood tests and in most situations clinical monitoring is at least as effective as blood level monitoring. **Most guidelines do not recommend routine blood level monitoring in children and young people.**

What NICE has said about ASM levels and adherence

2.1.6 Support people to self-manage their epilepsy and make informed choices by discussing the following issues with them during their first appointment:
• medications for epilepsy, the importance of adherence to medication and possible side effects

4.5.3 Consider monitoring antiseizure medication levels in people with epilepsy and any of the following:
• uncontrolled seizures
• side effects from their medication
• a specific clinical condition needing closer supervision (such as pregnancy or renal failure)
• poor adherence to medication.

4.6.6 Consider monitoring antiseizure medication levels in women or girls with epilepsy who are planning pregnancy and are considered to be at risk of their seizures worsening.

4.6.7 When starting monitoring in women or girls planning pregnancy, obtain a baseline (pre-conception) concentration of antiseizure medications (for example, carbamazepine, lamotrigine, levetiracetam, oxcarbazepine, phenobarbital and phenytoin) and check adherence to their medication.

4.6.9 If monitoring of antiseizure medications levels is carried out in pregnancy, discuss the results with the woman or girl with epilepsy to inform choices about any adjustments to doses.

4.6.3 Explain to women and girls who are pregnant or are planning pregnancy the importance of adherence to their antiseizure medications and that they should not stop their medication without medical supervision

7.1.5 Be alert to non-adherence to antiseizure medication, which can also be a cause of status epilepticus.

10.1.2 Be aware that potentially modifiable risk factors for SUDEP include:
• non-adherence to medication

10.2.2 Support people with epilepsy to take their medications as prescribed to reduce seizures. Explain that uncontrolled seizures increase the risk of epilepsy-related death, particularly for people with generalised tonic clonic seizures or focal to bilateral tonic-clonic seizures.

11.2.6 When discussing transition to adult epilepsy services with the young person, cover any issues of concern to the person, include…

- adherence to antiseizure medication

4.7 When can I stop anti-seizure medication?

In most children epilepsy is not a lifelong condition. In other words many children 'grow out of it'. However, this is no means certain and when it occurs is generally unpredictable. **Most children started on** anti-seizure medications **will become seizure free and in nearly all who achieve this there should be an attempt to withdraw anti-seizure medication.** On the basis of outcome studies, it is usually recommended that this be attempted once the child has been free of seizures for 2 years. Withdrawal may be considered in some children and young people earlier, in others later and in a very few it may not be appropriate to consider withdrawal. **The single most useful factor in helping to decide when to withdraw anti-seizure medications is the type of epilepsy or epilepsy syndrome diagnosis.**

What NICE 2022 said about discontinuing ASMs

4.7.1 Discuss the benefits and risks of discontinuing antiseizure medication with the person with epilepsy, and their family and carers as appropriate, as part of an ongoing assessment of their treatment at any appointment or review. Provide information about the risks and benefits in an accessible format.

4.7.2 After a person has been seizure-free for 2 years, carry out an individualised assessment to determine the risk of seizure recurrence if antiseizure medications are discontinued. This should be carried out by an epilepsy specialist if there is any doubt or concern about the risks.

4.7.3 When deciding whether to discontinue antiseizure medications, discuss with the person with epilepsy, and their family or carers if appropriate:
• their individualised risk assessment, including their risk of seizures recurring and, if appropriate, the risk of SUDEP
• the person's preferences and lifestyle, including the implications for driving if relevant.

4.7.4 If a decision is made to discontinue antiseizure medication, agree a plan with the person, and their family or carers if appropriate, based on the person's risk and preferences. The plan should include reducing their antiseizure medications gradually:
• For most medicines, this would typically be over at least 3 months.
• For benzodiazepines and barbiturates, this would typically be over a longer period to reduce the risk of drug-related withdrawal symptoms.

4.7.5 For people with epilepsy taking multiple antiseizure medications, discontinue their medications one at a time.

4.7.6 If seizures recur during or after discontinuation, reverse the last dose reduction and seek guidance from the epilepsy specialist, in line with the agreed plan.

4.7.7 After epilepsy surgery, discontinue antiseizure medications under the guidance of the epilepsy surgery centre.

6.5.7 Consider discontinuing antiseizure medication treatment in children with epilepsy with myoclonic-atonic seizures who are seizure-free for 2 years.

4.8 Rescue Medication

The term 'rescue medication' is used to cover the use of anti-seizure medications acutely to stop seizures rather than regularly to prevent seizures. The management of some children and young people will involve the use of regular anti-seizure medications and the provision of *rescue medication*. Other children and young people provided with rescue medication will not be treated with regular anti-seizure medication s.

Task 5:

The following statements concern the use of rescue medication. Indicate which you agree with and which you think are incorrect.		
		True/False
a)	All children and young people with epileptic seizures should be provided with rescue medication, because epileptic seizures should be stopped as quickly as possible to minimize brain damage.	
b)	Rescue medication has significant adverse effects, and its use should generally be restricted to children and young people with prolonged epileptic seizures.	
c)	There is no place for the use of rescue medication in children and young people with febrile seizures.	

Commentary 5:

You should have answered: False, True, False.

The vast majority of epileptic seizures do not cause harm. Significant concern regarding brain damage is confined to convulsive epileptic seizures lasting longer than 30 minutes. Most convulsive epileptic seizures are short lived (under 2 minutes). **Consequently, most children and young people with seizures do not require rescue medication.**

Although rescue medication is generally safe, significant adverse effects can occur. Of most concern, there is a risk of respiratory depression. On the other hand, prolonged convulsive epileptic seizures carry significant risk of permanent brain damage. Since this may occur when a seizure lasts more than 30 minutes, the aim is to stop seizures before the child has been convulsing for 30 minutes. Seizures are usually easier to stop earlier compared to later on. In other words, rescue medication given after 5 minutes is more likely to stop the seizure than if given after 10 minutes. Rescue medication is usually prescribed to children and young people who are considered to be at risk of prolonged convulsive epileptic seizures. This is usually on the basis that they have previously had one or more prolonged seizures. The child's carers need to be given explicit instructions as to when the drug should be given. Generally, this will be if the child continues to convulse for more than 5 minutes, but depending on the individual, it may be sensible to prescribe a different time. For example, if a child's usual seizures last around 5 minutes, it would be appropriate to give rescue medication for seizures lasting 6 minutes or longer.

One reason for prescribing rescue medication is for children with previous prolonged febrile seizures. Most children with febrile seizures do not require regular anti-seizure medication and most febrile seizures are short. However, febrile seizures can continue in some to over 30 minutes (febrile status epilepticus).

There are a number of anti-seizure medications that can be used as rescue medication. These include:

- Midazolam given *buccally* or *nasally*
- Diazepam given *rectally* (stesolid)
- *Paraldehyde* given rectally

Buccal midazolam is the rescue medication of choice in the UK compared to rectal preparations because of evidence of improved effectiveness and patient preference.

The carers of children and young people prescribed rescue medication must be given detailed training and written instructions on how and when to use it and what to do subsequently. This should include instructions as to when an ambulance should be called. Most ambulance crews will support the administration of rescue anti-seizure medications to children and young people.

It must be remembered that whilst only a minority of children and young people with epileptic seizures require rescue medication, **the carers of all children and young people with seizures should have an individualised plan as to what to do in the context of a prolonged epileptic seizure or a series of epileptic seizures without full recovery in between seizures.**

What NICE 2022 said about Status Epilepticus:

Initial treatment for generalised convulsive status epilepticus

7.1.1 Provide resuscitation and immediate emergency treatment for children, young people and adults who have convulsive status epilepticus (seizures lasting 5 minutes or more).

7.1.2 If the person with convulsive status epilepticus has an individualised emergency management plan that is immediately available, administer medication as detailed in the plan.

7.1.3 If the person with convulsive status epilepticus does not have an individualised emergency management plan immediately available:
• give a benzodiazepine (buccal midazolam or rectal diazepam) immediately as first-line treatment in the community or
• use intravenous lorazepam if intravenous access and resuscitation facilities are immediately available.

7.1.4 Be aware of the possible underlying causes of status epilepticus, including hypoglycaemia, eclampsia and alcohol withdrawal, which may need to be treated with additional medication.

7.1.5 Be alert to non-adherence to antiseizure medication, which can also be a cause of status epilepticus.

7.1.6 Be aware that non-epileptic seizures (dissociative seizures) can be similar in presentation to convulsive status epilepticus.

Management if initial treatment is unsuccessful

7.1.7 If convulsive status epilepticus does not respond to the first dose of benzodiazepine:
• call emergency services in the community or
• seek expert guidance in hospital.

7.1.8 Continue to follow the person's individualised emergency management plan, if this is immediately available, or give a second dose of benzodiazepine if the seizure does not stop within 5 to 10 minutes of the first dose.

7.1.9 If convulsive status epilepticus does not respond to 2 doses of a benzodiazepine, give any of the following medicines intravenously as a second-line treatment:
• levetiracetam
• phenytoin
• sodium valproate.

Take into account that levetiracetam may be quicker to administer and have fewer adverse effects than the alternative options.
In April 2022, this was an off-label use of levetiracetam. See NICE's information on prescribing medicines.
Follow the Medicines and Healthcare products Regulatory Agency (MHRA) safety advice on valproate use by women and girls.

7.1.10 If convulsive status epilepticus does not respond to a second-line treatment, consider trying an alternative second-line treatment option under expert guidance.

7.1.11 If convulsive status epilepticus does not respond to the second-line treatment options tried, consider the following third-line options under expert guidance:
• phenobarbital or
• general anaesthesia.

7.1.12 After an episode of convulsive status epilepticus, agree an emergency management plan with the person if they do not already have one and there is concern that status epilepticus may recur.

Repeated seizures or cluster seizures
7.2.1 Manage repeated or cluster seizures (typically 3 or more self-terminating seizures in 24 hours) as a medical emergency.
7.2.2 If a person has repeated or cluster seizures:
• follow their individualised emergency management plan, if this is immediately available or
• consider giving a benzodiazepine, such as clobazam or midazolam, immediately if they do not have an individualised emergency management plan immediately available.
7.2.3 Seek expert guidance if the person has further episodes of repeated or cluster seizures.
7.2.4 Agree an individualised emergency management plan with the person after repeated or cluster seizures if they do not have one already and there is concern that repeated or cluster seizures may recur.

Prolonged seizures
7.3.1 Manage prolonged convulsive seizures (any convulsive seizure that continues for more than 2 minutes longer than a person's usual seizure)

as a medical emergency.

7.3.2 If a person has a prolonged convulsive seizure:
• follow their individualised emergency management plan if this is immediately available or
• consider giving a benzodiazepine, such as midazolam or clobazam, immediately if they do not have an individualised emergency management plan immediately available.

7.3.3 After a prolonged convulsive seizure, agree an emergency management plan with the person if they do not already have one and there is concern that prolonged convulsive seizures may recur.

7.3.4 After a prolonged non-convulsive seizure (a non-convulsive seizure that continues for more than 2 minutes longer than a person's usual seizure), agree an emergency management plan with the person if they do not already have one and there is concern that prolonged non-convulsive seizures may recur.

4.9 The Role of Non-Anti-Seizure Medication Treatments

There is no evidence to support the use of complementary medicine in the management of children and young people with epileptic seizures. Similarly psychological interventions have not been shown to be effective in the prevention of epileptic seizures, although psychological interventions may be important in managing the mental health co-morbidities associated with epilepsy.

Children and young people whose seizures are resistant to treatment with standard anti-seizure medications should be referred to a tertiary epilepsy centre. Treatment modalities that are likely to be considered include:

- Newer anti-seizure medications
- Experimental anti-seizure medications in a research context
- Surgical treatment
- The *ketogenic diet*
- *Vagal nerve stimulation*

Surgical treatment of epileptic seizures is possible in a proportion of patients. **Epilepsy surgery has the potential to render some children and young people seizure free (i.e. 'cured') who have hitherto been resistant to anti-seizure medications. It should be considered in all children and young people with drug resistant seizures at a an early stage** (generally after 2 ASMs have been unsuccessful). Children and young people should be referred to recognised paediatric epilepsy surgery services.

What NICE says about non-pharmacological treatments

Ketogenic diet

8.1.1 Consider a ketogenic diet under the guidance of a tertiary epilepsy specialist, in people with:

• certain childhood-onset epilepsy syndromes (see also the section on treating childhood-onset epilepsies), for example:

— glucose transporter type 1 deficiency syndrome (GLUT1 deficiency syndrome)

— epilepsy associated with pyruvate dehydrogenase deficiency

— infantile spasms syndrome

— epilepsy with myoclonic-atonic seizures (Doose syndrome)

— Dravet syndrome

— Lennox–Gastaut syndrome

• drug-resistant epilepsy if other treatment options have been unsuccessful or are not appropriate.

Referral for resective epilepsy surgery assessment

8.2.1 Discuss the options for assessment for resective epilepsy surgery with people who have drug-resistant epilepsy, and their families or carers if appropriate. Explain what the process of surgical assessment involves as

well as the benefits and risks associated with surgical procedures.

8.2.2 Refer people with drug-resistant epilepsy, including those without identified MRI abnormalities, for consideration of assessment for resective epilepsy surgery:
• For adults, this should be to a tertiary epilepsy service.
• For children and young people, this should be to a tertiary paediatric neurology service for consideration of referral to a children's epilepsy service surgery centre.

8.2.3 For people with MRI abnormalities that indicate a high risk of drugresistant epilepsy, consider early referral to a tertiary epilepsy service for assessment, including an evaluation for resective epilepsy surgery if appropriate. Examples of specific lesions seen on MRI may include, but are not limited to, the following:
• hippocampal sclerosis
• malformations of cortical development
• epilepsy-associated low-grade tumours
• hypothalamic hamartomas
• neuronal migrational disorders
• tuberous sclerosis complex
• vascular malformations, including Sturge–Weber syndrome
• cerebral contusions from previous head injury.

8.2.4 Do not exclude people with learning disabilities or underlying genetic abnormalities from referral for resective epilepsy surgery assessment if it is indicated.

Vagus nerve stimulation
8.3.1 If resective epilepsy surgery is not suitable for a person with drugresistant seizures, consider vagus nerve stimulation as an add-on treatment to antiseizure medication. See also NICE's interventional procedures guidance on vagus nerve stimulation for refractory epilepsy in children.

8.3.2 Discuss with the person with epilepsy, and their family or carers if appropriate, the benefits and risks of vagus nerve stimulation before making a shared decision about having this procedure.

4.10 Additional Information

Why did it used to be thought that most people with epilepsy do not recover from it, if in fact, they do?

The main reason for the view that most people with epilepsy would continue to have seizures throughout their lives was because studies were done in big centres. By their very nature these institutions tended to attract those with the most difficult to treat epilepsy and, therefore, the experience gained in them gave a very skewed view.

Some animal experiments also tended to support the notion that recovery from epilepsy was unlikely. Particularly persuasive was the phenomenon of kindling. In this model epileptic seizures are produced using an electrical or chemical stimulus. The more seizures which have been induced the lower the intensity of the stimulus needed to induce further seizures. Eventually spontaneous seizures may occur.

Kindling, although easily induced in rodents is more difficult to induce in higher mammals such as dogs and cats and even more so in primates. Whether it ever occurs in man is unknown. If it does, it is probably uncommon.

People talk about the new and the old anti-seizure medications**. What do they mean by this?**

The last few decades have seen a large number of antiepileptic drugs introduced. It has become customary to refer to those available prior to 1989 as the established (or old) anti-seizure medications and those after 1989 as the new anti-seizure medications. The established and the new anti-seizure medications are listed below. Drugs with a narrow spectrum of activity have a suffix (N); those with a broad spectrum of activity have a suffix (B); the spectrums of Phenobarbital and ethosuximide are more complicated

Established anti-seizure medications

- Phenobarbital (Phenobarbitone)
- Phenytoin (N)
- Carbamazepine (N)
- Ethosuximide (N)
- Benzodiazepines such as clobazam and clonazepam (B)
- Sodium valproate (B)

New anti-seizure medications

- Vigabatrin (N)
- Lamotrigine (N)
- Gabapentin (N)
- Tiagabine (N)
- Oxcarbazepine (N)
- Topiramate (B)
- Levetiracetam (B)

- Zonisamide (N)
- Rufinamide (N)
- Lacosamide (N)
- Perampanel (N)

As previously noted, most children and young people are still started on an established anti-seizure medication as, in general, none of the new drugs have been shown to be clearly superior. However, the concerns regarding the use of sodium valproate in girls and women of child bearing potential has already been noted. In addition, there are two other important exceptions to the rule that most children and young people are started on either carbamazepine, lamotrigine, levetiracetam or sodium valproate:

- Vigabatrin with or without steroids are particularly effective against epileptic spasms (infantile spasms). It is recommended as first line treatment in these situations and specific treatment choice often depends on whether the child has tuberous sclerosis or not.

- Ethosuximide is a narrow spectrum agent effective against typical absence seizures. It is first line in the treatment of childood absence epilepsy due to it superior effecacy to lamotrigine and better side effect profile to sodium valproate.

If the initial anti-seizure medication fails, how should the second one be introduced?

Two approaches are possible:

- The new drug can be substituted for the first (sequential monotherapy).

- The new drug can be added to the first (polytherapy).

Task 4:

There are advantages and disadvantages of each approach. Can you think of one advantage and one disadvantage of each?
Monotherapy: Advantage - Disadvantage –
Polytherapy: Advantage – Disadvantage –

Commentary 4:

Sequential *monotherapy* has the advantage that it minimises the risk of adverse effects inherent with *polytherapy*. Its disadvantage is that if the drug which is being withdrawn is having some beneficial effect, the patient may experience an increase in seizures. This problem can be reduced if the new drug is introduced whilst the first is being gradually withdrawn.

Polytherapy has the advantage that the patient is not left 'unprotected' during the change-over. However, polytherapy carries with it a significantly greater risk of adverse effects than does monotherapy.

What NICE 2022 says about ongoing ASMs:

4.1.4 Review the diagnosis of epilepsy if seizures continue despite an optimal dose of a first-line antiseizure medication.

4.1.5 If first-line monotherapy is unsuccessful and epilepsy diagnosis remains confirmed, try monotherapy with another antiseizure medication, using caution during the changeover period:
• Increase the dose of the second medicine slowly while maintaining the dose of the first medicine.
• If the second medicine is successful, slowly taper off the dose of the first medicine.
• If the second medicine is unsuccessful, slowly taper off the dose of the second medicine and consider an alternative.

4.1.6 If monotherapy is unsuccessful, consider trying an add-on treatment.

4.1.7 When starting an add-on treatment, carefully titrate the additional medicine and review treatment frequently, including monitoring for adverse effects such as sedation.

4.1.8 If trials of add-on treatment do not result in a reduction in seizures, use the regimen that provides the best balance between effectiveness and tolerability of side effects.

4.1.9 Discuss with the person, and their family and carers as appropriate, the benefits of taking as few medicines as possible to maintain seizure freedom or control.

In what circumstances, if any, is it useful to measure anti-seizure medication levels?

Phenytoin is an anti-seizure medication that is **not** now widely used in children and young people in the UK. For pharmacological reasons, small changes to the phenytoin dose given can lead to very large changes in the levels of drug in the blood. Because of this, children and young people treated with phenytoin require their levels to be checked regularly.

It can also be useful to check levels when making major treatment changes, particularly when using two or more anti-seizure medications which are known to interact with one another. However, many specialists routinely make such changes without checking levels.

It can be useful to check drug levels if a child is admitted to hospital as an emergency, if there are symptoms of toxicity or if adherence issues are suspected.

Although drug levels are usually checked in the blood, they can also be checked in saliva.

5. PSYCHOSOCIAL ISSUES AND EPILEPSY SERVICES

5.1 Introduction

In this section you will take a holistic look at epilepsy, considering how epilepsy impacts on the whole life of the child and family.

5.2 Learning Objectives

By the end of this section you should:

1. Be able to describe the co-morbidities associated with epilepsy.
2. Be able to explain the potential educational impact of epilepsy.
3. Be able to explain why children and young people with epilepsy may be stigmatised.
4. Be able to give appropriate safety and participation advice for children and young people with epilepsy.
5. Have knowledge of the social services support available for children and young people with epilepsy and their families.
6. Be able to advise children and young people, parents, carers and other professionals where appropriate information on epilepsy can be obtained.
7. Be able to describe appropriate care pathways for children and young people with epilepsy.

5.3 Epilepsy and co-morbidities

Epilepsy in children and young people is associated with a range of neurodevelopmental, behavioural and mental health problems.

Task 1:

Write down three neurodevelopmental problems which you think might be associated with epilepsy.	
1.	
2.	
3.	

Commentary 1:

Children and young people with epilepsy may also have:

- Motor problems, such as *cerebral palsy*
- *Intellectual disability*, which may be mild, moderate or severe
- Behavioural problems
- Sensory problems (particular visual and hearing problems)
- Autistic spectrum disorder
- Attention deficit (hyperactivity) disorder

These **additional neurodevelopmental problems are, in most cases, not caused by the epilepsy, but rather share the same underlying cause as the epilepsy.** For example, a child who has had birth asphyxia may, as a consequence, develop cerebral palsy, severe intellectual disability, visual problems and epilepsy.

At any particular time one of these problems may be more or less significant.

5.4 Epilepsy and Neurodevelopmental Problems

Does epilepsy cause neurodevelopmental problems?

This is both a very important question and a very difficult one to answer. Perhaps the best place to start is to remember that epilepsy is not a single disorder, but rather very many different disorders. Some of these are not usually associated with significant neurodevelopmental problems, others are sometimes associated with neurodevelopmental problems and others are expected to be associated with neurodevelopmental problems.

The current thinking related to evidence arising from research is that the underlying cause of epilepsy (whether identified or not) may impact on neurodevelopment in addition to either seizures or significant electrical discharges, the latter which can be detected by the EEG in the wake or sleep states. Theses frequent discharges are seen in epileptic encephalopathies described below. One may then think of epilepsy in some syndromes as a symptom of an underlying abnormality of brain development.

Some epilepsies are generally not associated with significant neurodevelopmental problems. Examples are juvenile absence epilepsy, juvenile myoclonic epilepsy, childhood absence epilepsy and self limited epilepsy with centrotemporal spikes. Occasionally neurodevelopmental problems may occur, but these are usually relatively mild. If a child with one of these syndromes presents with developmental or educational problems, referral to a paediatric neurologist is merited.

Another important group of epilepsies are those where an underlying cause is known. **These epilepsies are often associated with pre-existing neurodevelopmental problems.** However, not infrequently (but by no means inevitably) new neurodevelopmental problems develop after the onset of seizures. Children with epilepsy resistant to treatment are more likely to have developmental difficulties.

An E*pileptic encephalopathy* is when cognitive and other impairments have evolved as a direct result of ongoing epileptic activity (either frequent seizures or severely abnormal inter-ictal discharges on the EEG) over and above any underlying diagnosis. Often these epilepsies are resistant to anti-seizure medications. Two epilepsy syndromes which you may have heard of which often have an epileptic encephalopathy component are *Lennox Gastaut Syndrome* and *West Syndrome (previously known as West Syndrome*).

What sort of neurodevelopmental problems can be associated with epilepsy?

When children with epilepsy develop neurodevelopmental problems, these usually take the form of impairments of higher intellectual functions (such as memory impairments, processing speed, visuo-spatial difficulties and language problems) or behavioural problems (such as problems with attention and concentration, hyperactivity and conduct problems). Approximately 40% of school age children with epilepsy show educational underachievement in comparison to their cognitive ability.

Do children with epilepsy often need support at school?

Children with epilepsy often benefit from additional support at school and there is a case for suggesting that every child with epilepsy should have their educational progress monitored more closely than other children. It is important that difficulties are picked up and support provided before children fail as this can affect their confidence and self-esteem and in some children manifest with behaviour problems at school.

Turning now to the acute effect of seizures. **Temporary brain dysfunction after seizures is common**. This is most dramatically seen following some focal motor seizures which may be followed by temporary paralysis of a limb or limbs (*Todd's paresis*). Much the same thing can occur following other seizure types. For example, memory functions may be impaired following some types of seizures. This may be much less obvious to the observer. Although it is temporary, when repeated many times, it may significantly interfere with school progress. In recent years it has been shown that some children and young people have brief impairments of cognitive function during *epileptiform EEG* discharges (not associated with clinical seizures). This is known as *transient cognitive impairment*.

Finally**, anti-seizure medications may have adverse cognitive and behavioural effects.** Given that anti-seizure medications act on the brain,

it is not surprising that they can cause cognitive and behavioural problems. However, for most anti-seizure medications used routinely in children and young people such adverse effects are quite rare unless the drug causes drowsiness. Nevertheless, when a child with epilepsy is reported to be having school difficulties, whether in term of learning or behaviour, it is important to consider whether treatment may be causing or contributing to this.

What NICE 2022 says about wider aspects of care

Providing coordinated care

9.1.1 Be aware that there is a higher prevalence of mental health difficulties, learning disabilities, neurodevelopmental comorbidities (for example, attention deficit hyperactivity disorder and autism spectrum disorder) and dementia, and a higher risk of suicide in people with epilepsy compared with the general population.

9.1.2 Provide coordinated care for people with epilepsy who have a mental health condition or learning disability using a multidisciplinary team approach.

9.1.3 Be aware that children and young people with a complex childhood epilepsy syndrome can have developmental difficulties and cognitive impairment, and may need additional support from a multidisciplinary team.

9.1.4 Ensure effective communication and liaison between healthcare professionals across the relevant services involved in the care of people with epilepsy and a mental health condition to agree and plan care across services.

9.1.5 For people with epilepsy who have a learning disability, a mental health problem or challenging behaviour, or who have dementia, follow the recommendations on coordinating care in NICE's guidelines on mental health problems in people with learning disabilities, challenging behaviour and learning disabilities and dementia.

9.2.2 Review neurodevelopment, cognitive function, mental health, social and emotional wellbeing, and learning disabilities as part of the routine management for people with epilepsy.

Support and treatment

9.2.1 Recognise that a diagnosis of epilepsy can have a significant adverse impact on a person's mental health and that people with epilepsy may feel socially excluded and stigmatised.

9.2.2 Review neurodevelopment, cognitive function, mental health, social and emotional wellbeing, and learning disabilities as part of the routine management for people with epilepsy.

9.2.3 Offer assessment and provide mental health support and treatment for people with epilepsy and depression in line with NICE's guidelines on depression in adults with a chronic physical health problem and depression in children and young people.

9.2.4 Be alert to anxiety, other mental health difficulties and the risk of suicide in people diagnosed with epilepsy. If mental health difficulties are suspected, consider referral and follow the recommendations in NICE's guidelines on:

- attention deficit hyperactivity disorder
- autism spectrum disorders in under 19s
- autism spectrum disorder in adults
- common mental health problems
- mental health problems in people with learning disabilities
- generalised anxiety disorder and panic disorder in adults
- psychosis and schizophrenia in adults
- psychosis and schizophrenia in children and young people.

5.5 Epilepsy and Mental Health Problems

Mental health problems are significantly more common in children and young people with epilepsy than in the general population and are also more common than in children and young people with chronic disorders not involving the CNS. In one study of children and young people with 'uncomplicated' epilepsy:

- 13% had emotional disorder
- 7.5% had conduct disorder
- 5% had mixed mental health disorders
- 2% had hyperkinetic disorder

Other mental health disorders associated with epilepsy include childhood psychoses.

All professionals involved in caring for children and young people with epilepsy should be alert to the occurrence of mental health problems, many of which can be helped by suitable and timely interventions. Children and young people with epilepsy should have access to effective mental health services and treatments.

5.6 Epilepsy and Stigma

Stigma occurs when a particular aspect of an individual's behaviour or character is perceived negatively and used to define that person in a negative way.

Task 2:

It should not be difficult to think of reasons why a child with epilepsy's behaviour or character may be perceived negatively. Write a few down:

Commentary 2:

Amongst the many you could have listed are:

- Occurrence of unpredictable, often frightening seizures
- Needs to take drugs
- Reduced school attendance
- Restrictions on activities due to safety considerations
- Presence of co-morbidities (cerebral palsy, intellectual disability, behaviour problems)

In addition to these fairly obvious reasons, false beliefs in some settings concerning epilepsy may also contribute to the stigma associated with epilepsy:

- Ideas concerning possession by demons
- Ideas concerning the relationship between epilepsy and sex

5.7 Safety Considerations

Most children and young people with epilepsy are restricted in their activities; generally because of fear of death or injury should a seizure occur. **Generally the perceived increased risk of epileptic seizures is much greater than is actually the case**. The general approach should be to encourage normal activities, including sport as much as possible and to minimize risks by taking common sense precautions.

The assessment of risk must be individualised. What might be dangerous for a child having daily atonic seizures, might pose no risk for a child with occasional focal seizures occurring without any impairment of awareness.

Generally, the four most risky situations are:

- Water, including swimming and bathing
- Heights
- Heat (cookers, fires, etc.)
- Traffic

There is virtually no evidence that 'ordinary' sports, including contact sports, pose a significant risk, even to those with poorly controlled seizures.

Task 3:

Take a look at the website of SUDEP Action www.sudep.org Read the Epilepsy and Risk – Parent and Carer's Guide (sudep.org/childhood-adolescence-and-risk) Have a look at some of the advice given, for example, about swimming and climbing.

Task 4:

For teenagers, whether or not they will be allowed to drive can be very important. Look at the website of Epilepsy Action and see what they say about UK driving regulations.

Commentary 4:

It is probably better if you direct patients and their families to suitable advice (web-based or written) concerning psychosocial issues wherever possible as it means they will be able to use these resources to answer other questions which are likely to arise from time to time. Other useful websites are:

Young Epilepsy	www.youngepilepsy.org.uk
Epilepsy Society	epilepsysociety.org.uk
Epilepsy Scotland	www.epilepsyscotland.org.uk

5.8 Organisation of Services

The services available for children and young people with epilepsy in the UK are of very variable quality. In 2002 The National Sentinel Clinical Audit of Epilepsy-Related Death was published. The audit considered 22 deaths in children and young people with epilepsy and found that the overall care was inadequate in 77% and that in 59% death may have been possibly or potentially avoidable. Two paragraphs from the report are worth quoting:

"From the available documentation, the audit found deficiencies in access to and quality of care, communication between clinical staff and between healthcare professionals and patients and their carers, documentation and post-mortem investigation of epilepsy-related deaths.

These system failures need to be addressed when planning professional education, clinical and audit guidelines and systems for service delivery. Particular concerns are inadequate access to appropriate epilepsy care; lack of education of healthcare professionals about the principles of epilepsy management and the risks of epilepsy-related deaths; poor communication with patients and their families and between professionals; documentation and post-mortem investigation of epilepsy-related death."

In part the **PET courses** were commenced to address these deficiencies.

Epilepsy12 (www.epilepsy12.com) is a more recent and ongoing comprehensive UK audit programme which is showing significant improvements but continuing gaps and variation in provision.

There is increasing efforts to coordinate professional and managerial support for epilepsy care within the context of a clinical network. Such a networks. These can be defined as follows:

"Linked groups of health professionals and organisations from primary, secondary, and tertiary care working in a co-ordinated manner, unconstrained by existing professional and organisational boundaries to ensure equitable provision of high quality effective services!"

NICE has given detailed guidance regarding key aspects of service provision. Amongst its key recommendations are:

- First aid advice should be given
- Children and young people with epilepsy should have individualised care plans
- There should be regular specialist review

What NICE 2022 says about approaches to assessment and ongoing care:

Referral after a first seizure
Refer children, young people and adults urgently (for an appointment within 2 weeks) for an assessment after a first suspected seizure:
• For adults, refer to a clinician with expertise in assessing first seizures and diagnosing epilepsy.
• For children and young people, refer to a paediatrician with expertise in assessing first seizures and diagnosing epilepsy.

Referral after remission
1.1.2 Refer children, young people and adults urgently (for an appointment within 2 weeks) for an assessment if they have a seizure recurrence after a period of remission.

Assessing the risk of a second seizure
1.1.3 When a child, young person or adult presents with a first seizure, carry out an individualised assessment of their risk of a second seizure.

1.1.4 In adults, assessment should include checking for the following modifiable factors that may increase the risk of a second seizure:
• an underlying mental health problem (such as depression, anxiety, psychosis and alcohol or substance misuse)
• vascular risk factors (for example, diabetes, hypertension, atrial fibrillation)
• sepsis.

1.1.5 Be aware that children presenting with a first afebrile seizure (seizure without a fever) are at an increased risk of further afebrile seizures, especially within 6 to 12 months, compared with children with a febrile seizure (seizure with a fever).

1.1.6 Be aware that children presenting with complicated febrile seizures (febrile seizures that last longer than 10 minutes or febrile seizures associated with other features, such as weakness, on one side of the body) may be at higher risk of epilepsy, especially if other predisposing risk factors for epilepsy are present.

1.1.7 Using a person-centred approach, discuss with the person, and their family and carers if appropriate, their individualised risks for further seizures. This should include any mental, physical and social factors identified as possible risk factors and how these may be modified.

Information and support after a first seizure
1.1.8 After a first seizure, give the person, and their family and carers if appropriate, information about:
• how to recognise a further seizure

• first aid and initial safety guidance in case of another seizure (see safety issues in box 1)
• any changes they can make to reduce their risk of another seizure
• who they should contact if they have a further seizure while awaiting their appointment for assessment and diagnosis.

1.1.9 After a first afebrile seizure in a child, explain to their parents or carers how to self-refer the child urgently if they have a further seizure.

2.1.7 Provide the person with epilepsy, and their family or carers if appropriate, with a copy of their care plan, which includes details of their care and support as discussed and agreed with the person, and their family or carers if appropriate.

4.5.2 Discuss monitoring reviews with children and young people with epilepsy and their families and carers if appropriate, and agree a frequency for regular reviews that is:
• individually tailored to the child or young person's needs, preferences and the nature of their epilepsy and
• at least every 12 months.

Epilepsy specialist nurses
11.1.1 Ensure that all children, young people and adults with epilepsy have access to an epilepsy specialist nurse who:
• has a central role in providing information, education and support (see box 1 for information that should be covered)
• supports epilepsy specialists and healthcare professionals in primary and secondary care, and in educational, respite and social care settings
• is a point of contact for, and facilitates access to, other community and multiagency services.

11.1.2 Offer people with epilepsy an information and care-planning session with an epilepsy specialist nurse that includes emotional wellbeing and selfmanagement strategies promoting inclusion and participation.

11.1.3 For people with epilepsy who continue to have seizures, offer epilepsy specialist nurse sessions:
• at least twice a year and
• after A&E department visits.

11.1.4 Consider epilepsy specialist nurse-led group sessions for education and information giving in young people and adults with epilepsy.

Risk factors
10.1.1 Be aware that epilepsy is associated with an increased risk of premature death, including a risk of sudden unexpected death in epilepsy (SUDEP).

10.1.2 Be aware that potentially modifiable risk factors for SUDEP include:
• non-adherence to medication
• alcohol and drug misuse
• having focal to bilateral tonic-clonic seizures or generalised tonic-clonic seizures
• having uncontrolled seizures
• living alone
• sleeping alone without supervision.

10.1.3 Be aware that the risk of epilepsy-related death is increased in people with:
• previous brain injury
• previous central nervous system infection
• metastatic cancer
• previous stroke
• abnormal neurological examination findings.

10.1.4 Discuss with people with epilepsy, and their families and carers if appropriate, their individual risk of epilepsy-related death, including SUDEP, from the time of diagnosis onwards. For young children, this discussion should be with the child's parents or carers. Discussion should include:
• supporting them to understand the risks of epilepsy-related death, including SUDEP
• exploring and agreeing ways to reduce the risks.

10.1.5 Discuss the risk of SUDEP with people who have seizures during sleep and, if appropriate, include their families and carers. Provide information on minimising risks, including taking their medication as prescribed.

GLOSSARY

Absence seizure – Strictly speaking an absence seizure is a type of generalised seizure in which the main manifestation is a brief impairment of awareness. However, the term is also sometimes used mistakenly and confusingly to mean any seizure in which the main manifestation is an impairment of awareness.

Anoxic seizure – A term which can be used synonymously with syncope. However, more usually it is reserved for syncopes which include, in addition to a loss of awareness, prominent motor manifestations, such as body stiffening and/or twitching jerking of the limbs

Drop seizure – An epileptic seizure in which the principle manifestation is a drop to the ground. It is usually caused by a tonic, atonic or myoclonic seizure

Ataxia – A disorder of balance

Atrophy – A term implying shrinkage of a tissue or body part

Atonic epileptic seizure – A type of generalised or focal epileptic seizure manifested by a loss in postural tone which can affect the whole body or only part of it

Atypical absence seizure – A generalised epileptic seizure usually occurring in children and young people with other neurological impairments. Its manifestations are similar to a typical absence seizure but the onset and cessation are often less abrupt and the EEG is different

'Benign epilepsy' – A historic term used to denote an epilepsy which is characterised by epileptic seizures that are easily treated, or require no treatment, and remit without sequelae

Self limited epilepsy with centro-temporal spikes (SeLECT)- Previously known as Rolandic epilepsy, benign epilepsy with centro temporal spikes and childhood epilepsy with centrotemporal spikes. It is one of the commonest focal epilepsies encountered in school age children

Brain maldevelopment – A term whose meaning is very close to that of brain malformations

Brain malformations – A group of disorders which can give rise to epilepsy in which the brain has developed abnormally in the womb giving rise to a structural abnormality of the brain usually apparent on brain scans, especially MRI brain scans

Breath holding spells – A disorder, usually encountered in infancy and young children, in which emotional stimuli or minor trauma is quickly followed by non-epileptic syncope. Prior to losing awareness the child often cries and appears to hold the breath in expiration. Breath holding can be divided into **blue** (or **cyanotic**) **breath holding** and **white** (or **pallid**) **breath holding**. The latter is now more correctly termed reflex anoxic seizures

Carbamazepine – A very commonly prescribed anti seizure medication mainly effective against focal epileptic seizures

Cardiac syncope – A syncope arising as a consequence of dysfunction of the heart. Usually this involves some disturbance of the cardiac rhythm (arrhythmias), but structural heart disease can also give rise to cardiac syncopes

Cataplexy – A rare symptom, often occurring with narcolepsy, in which emotion (such as laughter) triggers a diffuse loss of muscle tone which can mimic an atonic seizure

Cerebral palsy – A term used to denote a group of disorders characterised by abnormalities of movement and posture caused by non-progressive disorders of the developing brain

Chromosomes – The chromosomes are rod shaped structures within the nuclei of cells. They comprise sequences of genes

Compliance – A term denoting adherence to a prescribed drug regime. Adherence is the preferred term

Concomitant medication – Medication taken at the same time as another medication. In this situation there is always the possibility of drug interactions

Convulsion – The term "convulsion" is a popular, ambiguous, and unofficial term used to mean substantial motor activity during a seizure. In some languages, convulsions and seizures are considered synonyms and the motor component is not clear. (ILAE, 2017). The term in PET courses refers to any seizure in which there is prominent generalised or focal motor activity, such as stiffening, repetitive jerking or thrashing movements. It should not necessarily imply an event is epileptic or be seen as implying a particular epileptic seizure type.

CT brain scan – A type of scan which produces a series of pictures showing the structure of the brain. It involves the use of x rays

Developmental and epileptic encephalopathy – a type of epilepsy associated with developmental impairment where the developmental impairment is due to **BOTH** the underlying etiology, independent of the epileptic activity, **AND** the superimposed epileptic encephalopathy. An epileptic encephalopathy is where the epileptic activity itself contributes to severe cognitive and behavioural impairments above and beyond what might be expected from the underlying pathology alone.

A developmental encephalopathy – this simply reflects and individual with some degree of developmental delay or regression. The individual may or may not have epilepsy . If they do have epilepsy, they would be classified as a developmental encephalopathy and epilepsy. More recently this group is being referred to as having Intellectual disability and epilepsy (ID+E). In these individuals the underyling aetiology is causing both the developmental impairment and the epilepsy but the epilepsy (ie seizures and intericatal discharges are not impacting negatively on development).

Diazepam – An anti-seizure medication (also called valium) which is occasionally used as rescue medication and can be given rectally or intravenously

Drop attack – A term synonymous with astatic seizure

Dyskinesias – Non-epileptic movement disorders characterised by different types of abnormal movements

Dyspraxia – A term implying that the person has problems sequencing together motor tasks.

ECG – Short for *electrocardiogram.* An investigation, very useful in people with suspected disturbances of cardiac rhythm, in which the electrical activity of the heart is recorded using electrodes applied to the chest.

EEG – Short for *electroencephalogram.* An investigation, very useful in people with epilepsy, in which the electrical activity of the brain is sampled using an array of electrodes usually applied to the scalp. The investigation is painless. The investigation is essential to aid in the determination of the epilepsy syndrome.

Encephalitis – Inflammation of the brain, usually caused by virus infections

Epilepsy – A term covering a large group of disorders characterised by the tendency to have recurrent epileptic seizures

Epilepsy surgery – A term used to denote the surgical treatment of epileptic seizures. The surgery either involves removing areas of brain tissue which are giving rise to epileptic seizures (resective epilepsy surgery) or procedures designed to interfere with the spread of epileptic discharges (functional epilepsy surgery)

Epilepsy syndrome – This has historically also been referred to as an 'electroclinical syndrome'. The 'official definition is "A complex of signs and symptoms that define a unique epilepsy condition with different aetiologies". More loosely put an epilepsy syndrome is a type of epilepsy

Epileptic activity - epileptic activity involves the excessive and/or hypersynchronous discharge of neurones (brain cells). Loosely speaking, it can be considered as a disturbance in the electrical activity of the brain

Epileptic encephalopathy - A condition in which epileptic activity in the brain (seizures and/or epileptiform discharges on the EEG between seizures) icontributes to a progressive disturbance in cerebral function. An epileptic encephalopathy is where the epileptic activity itself contributes to severe cognitive and behavioural impairments above and beyond what might be expected from the underlying pathology alone.

Epileptic seizure – A type of seizure which arises as a consequence of epileptic activity in the brain. The manifestations of epileptic seizure are protean. The 'official' definition of an epileptic seizure is 'manifestation(s) of epileptic (excessive and/or hypersynchronous), usually self-limited activity of neurones in the brain

Epileptiform activity – Abnormalities seen on the EEG which are strongly associated with an increased risk of epilepsy

Epileptology – The medical specialty concerned with the diagnosis and treatment of the epilepsies

Faint (also called **syncope**) –Faints can have various triggers, but all are characterised by a temporary reduction in the blood flow to the brain sufficient to cause loss of awareness

Fit – A rather imprecise term sometimes used synonymously with *epileptic seizure*

Focal motor onset seizure - A focal epileptic seizure type where the seizure starts with motor features, such as jerking or thrashing of the certain limbs

Focal onset seizure – Conceptualized as originating within networks limited to one hemisphere. These may be discretely localized or more widely distributed. More loosely stated, a focal epileptic seizure is one which starts from a localized part of the brain

Focal sensory onset seizure – A focal epileptic seizure in which the first signs are sensory symptoms, such as hallucinations of smell, taste, hearing and vision or 'experiential phenomena' such as feelings of fear, *déjà vu*, etc.

Frontal lobe seizure – A focal epileptic seizure arising from one or other of the frontal lobes of the brain. The frontal lobes are involved in the control of movements and in various higher cognitive functions. The manifestations of frontal lobe seizures reflect these functions

Full blood count – Shorthand for a series of blood tests in which the concentration of haemoglobin and of various cells in the blood is measured

Generalised onset seizure – *Conceptualized as originating at some point within, and rapidly engaging, bilaterally distributed networks. …can include cortical and subcortical structures, but not necessarily include the entire cortex.* More loosely stated, a generalised epileptic seizure is one which starts from both sides of the brain simultaneously

Generalised tonic clonic seizure – A type of epileptic seizure in which the person simultaneously loses awareness and becomes stiff all over (the tonic phase). This is then followed by repetitive jerking of all four limbs (the clonic phase).

Genetic investigations – Chromosome and DNA tests usually done on blood samples (although occasionally other tissues such as skin are used) used to detect genetic disorders

Grand mal – An imprecise term (best avoided) used to denote 'major' epileptic seizures. What is meant by 'major' varies from one clinician to another, but will include GTCS

Hepatic (liver) function tests – Blood tests commonly used to screen for liver disease/dysfunction

Hypernatraemia - A term indicating an abnormally high blood sodium level

Hypocalcaemia - A term indicating an abnormally low blood calcium level

Hypoglycaemia – A term indicating an abnormally low blood sugar level

Hyponatraemia - A term indicating an abnormally low blood sodium level

Hypoxic-ischaemia– A b state caused by a lack of blood and/or oxygen to the brain

Ictal – A term meaning '*seizure*'. An ictal EEG is an EEG recording whilst a seizure is occurring

Idiopathic – A term referring to a specific group of genetic gereralised epilepsies which comprises childhood absences epilepsy, juvenile absence epilepsy, juvenile absence epilepsy and epilepsy with generalised tonic clonic seizures alone.
Idiopathic generalised epilepsy – A group of epilepsies for which no cause can be found, occurring in otherwise healthy people and characterised by the occurrence of one or more generalised seizure types. This term was withdrawn from ILAE recommendations in 2011

Idiosyncratic reactions – Unexpected/unpredictable adverse drug effects

Incidence (of epilepsy) – The number of new people diagnosed annually in a given population

Interictal – Between seizures. Hence an interictal EEG is one recorded between seizures

International League Against Epilepsy (ILAE) – In its own words:

The International League Against Epilepsy (ILAE) is the world's pre-eminent association of physicians and other health professionals working towards a world where no persons' life is limited by epilepsy. Its mission is to provide the highest quality of care and well-being for those afflicted with the condition and other related seizure disorders.

The League aims:

- To advance and disseminate knowledge about epilepsy
- To promote research, education and training
- To improve services and care for patients, especially by prevention, diagnosis and treatment

Intracranial bleeding – Bleeding into or around the brain

Ketogenic diet – A treatment for drug resistant epilepsy which involves giving the patient a diet very high in fats. The excess fats are converted into ketones, the presence of which appears to exert an antiepileptic effect

Lamotrigine – An anti-seizure medication active against both focal and generalised epileptic seizures and epilepsies

Intellectual disability – Also known as learning disability in the UK. A term used to denote different degrees of impaired neurodevelopment and ongoing cognitive function. Mild intellectual disability implies a score on IQ type tests of under 70. Severe intellectual disability implies a score on IQ type tests of under 35.

Lennox Gastaut syndrome – A type of developmental and epileptic encephalopathy usually occurring from early to mid childhood

Localisation-related epilepsy – Old term for 'focal epilepsy'. Focal epilepsy is the preferred term

Localisation-related seizure - Old term for 'focal seizure'. Focal seizure is the preferred term

Long QT syndromes – A group of cardiac disorders characterised by the occurrence of syncopes associated with a characteristic appearance on ECG traces. They can be associated with sudden death and are sometimes misdiagnosed as epilepsy

Mesial temporal sclerosis – A common cause of temporal lobe epilepsy. The term implies scarring of the structures lying in the medial part of one or other of the temporal lobes

Metabolic disorders – A large group of generally very rare conditions many of which affect the brain and include in their manifestations epileptic seizures. Their main feature in common is that they involve some problem interfering with the myriad of metabolic pathways in the body. These pathways are responsible, for example, for how the body handles food and stores and utilizes energy

Meningitis – Inflammation of meninges around the brain, usually caused by infections

Midazolam – An anti-seizure medication usually used as rescue medication and usually given buccally (into the cheeks)

MRI brain scan – A type of brain scan which produces a series of pictures showing the structure of the brain. It is generally far more sensitive than CT. It involves the use of very strong magnets

Myoclonic seizure – A type of generalised epileptic seizure characterised by a sudden shock like contraction of a muscle or a group of muscles. NB. not all types of myoclonus are epileptic

Narcolepsy–cataplexy - a lifelong neurological disorder of state boundary control in which the distinctions between sleep states, particularly REM sleep, and wakening are blurred.

Neurocutaneous disorder – The neurocutaneous disorders are a group of condition which, for embryological reasons, have both skin abnormalities and brain malformations/maldevelopments. They are commonly associated with epilepsy. Examples include tuberous sclerosis, neurofibromatosis and Sturge Weber syndrome

Neurodegenerative disease – A disease in which there is a loss of acquired skills caused by the death of nerve cells. These conditions commonly give rise to dementia. Many metabolic disorders behave in this manner. Epilepsy is common in neurodegenerative diseases

Neurodevelopmental problems – A broad term used to indicate that a child has motor, sensory, cognitive and/or behavioural problems

Neurometabolic investigations – A series of blood, urine and sometimes other tests used to detect metabolic disorders

Non-epileptic seizure – A seizure which is caused by any mechanism other than epileptic activity in the brain. Common types of / causes of non-epileptic seizures include faints, reflex anoxic seizures, cardiac syncopes, functional seizures and some movement disorders.

Occipital lobe seizure - A focal epileptic seizure arising from one or other of the occipital lobes of the brain. The occipital lobes are involved in the perception of visual stimuli. The manifestations of occipital lobe seizures reflect this function

Paraldehyde – An anti-seizure medication usually used as rescue medication and given rectally

Parietal lobe seizure – A focal epileptic seizure arising from one or other of the parietal lobes of the brain. The parietal lobes are involved in the perception of sensations such as touch, temperature and pain. The manifestations of parietal lobe seizures reflect this function

Partial seizure – Old term for 'focal seizure'. Focal seizure is the preferred term

Photosensitivity – A term implying that a person's epileptic seizures are likely to be triggered by photic (light) factors and/or to signify the occurrence of certain epileptiform abnormalities on the EEG in response to intermittent photic stimulation. Not everyone with photosensitivity on their EEG has seizures triggered in this way.

Prevalence (of epilepsy) – The number of people with epilepsy at any given time in a particular population

Reflex anoxic seizure – A disorder, mainly of infancy and early childhood characterised by anoxic seizures due to temporary pauses in the heart rhythm and usually triggered by minor bumps. An alternative term is *white breath-holding*

Renal (kidney) function tests – Blood tests used to screen for kidney disease/dysfunction and for abnormalities in the concentrations of salts, such as sodium, in the blood

Rescue medication – When used in the context of epilepsy, this term denotes the use of anti seizure medication to stop prolonged epileptic seizures or clusters of epileptic seizures. It is also known as emergency medication.

Resistant (drug resistant) epilepsy – A term implying the continuation of epileptic seizures despite appropriate treatment. Epilepsies are often said to be drug resistant after there has been a failure to respond to two suitable anti seizure medications at adequate doses.

Rolandic epilepsy – A historic name for Self limited epilepsy with centro-temporal spikes

Seizure – A broad term which can be used to denote any paroxysmal event. The term applies to, amongst others, events such as faints and collapses of cardiac origin as well as to epileptic seizures. However, it is often used interchangeably with *epileptic seizure* which can cause confusion.

Semiology – Meaning the clinical features of a seizure

Sodium valproate – A commonly prescribed broad spectrum anti-seizure medication

Status epilepticus – An epileptic seizure lasting longer than 5 minutes or a series of epileptic seizures over a period of 5 minutes without full recovery between seizures

SUDEP – An acronym for sudden, unexpected, witnessed or unwitnessed, non-traumatic and non-drowning death in patients with epilepsy with or without evidence of a seizure, and excluding documented status epilepticus, in which post-mortem examination does not reveal a toxicological or anatomical cause of death

Syncope – A term used to denote a type of non-epileptic seizure caused by a temporary mismatch in the supply of blood and/or oxygen to the brain in relation to its needs. The cardinal feature of syncope is loss of (or impairment) in awareness

Temporal lobe seizure - A focal epileptic seizure arising from one or other of the temporal lobes of the brain. The temporal lobes are involved in the perception of sound, taste and smell and in the experience of emotion. The manifestations of temporal lobe seizures reflect these functions

Teratogenicity – A term indicating the capacity of an agent (e.g. an infection, drug or irradiation) to cause damage to the unborn child

Tonic seizure – A type of epileptic seizure whose principle manifestation is stiffening longer than 3 seconds (which can affect the whole body or only part of it). A tonic seizure can be focal onset, generalised onset or unknown onset.

Transient cognitive impairment – Brief impairment of cognitive functions associated with epileptiform EEG discharges

Typical absence seizure - A generalised seizure type usually occurring in otherwise healthy children and young people and mainly manifest with a brief impairment of awareness of abrupt onset and cessation. The seizure is accompanied by a characteristic EEG appearance known as '3Hz spike and wave'

Vagal nerve stimulation - A treatment for drug resistant epilepsy which involves implanting an electrical stimulator under the skin of the chest wall. This is used to stimulate the vagus nerve in the neck. This stimulation exerts an antiepileptic effect on the brain

Vascular malformation – An abnormality consisting of abnormally formed blood vessels. Some vascular malformations are located within the brain. They can give rise to various problems, such as bleeding and epilepsy

West syndrome – An historic epilepsy syndrome now called infantile epileptic spasms syndrome epileptic encephalopathy occurring in babies and infants and characterised by seizures known as epileptic spasms (also called infantile spasms)