CONVULSIONS (INCLUDING EPILEPSY) IN CHILDHOOD*

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Of all the upsets which can happen to the infant or child, it would be safe to say that none is as alarming to the parents as a convulsion. A good knowledge of the causes of convulsions is therefore essential, if one is to handle the situation well, and relieve the parental anxiety with authority.

The diagnosis may sometimes be difficult, for even 'windy pains' with screaming may simulate a convulsion in the parental mind. More often than not, we must base our diagnosis on the description given to us by the parents, as the attack is over before we see the child. Petit mal may be so fleeting that it can, for some time, be mistaken for a mannerism by the parents.

When called to a child with a convulsion nothing can replace a very careful physical examination. The throat and ears should be viewed to exclude infection; the heart, lungs, and abdomen should also be examined, and, when possible, a specimen of urine should be analysed for sugar, acetone, albumen, blood, or pus. The eye grounds should be scrutinized for papilloedema and it should be ascertained whether there is a squint; the remainder of the central nervous system should be run over, and this examination should include testing for Kernig's sign. An examination of the nervous system of an infant or child is less informative than that of an adult, as the presence or absence of, for example, the knee jerks, is not so significant.

I propose describing what is usually called 'epilepsy' last of all.

Since convulsions are a symptom and not a disease, it would be well to begin by enumerating the various conditions which will give rise to this symptom.

Common Causes of Convulsions

Congenital Malformation of the Brain. Convulsions due to some failure of the brain to develop may show themselves at any age. So-called cerebral agenesis, or arrested development of the brain, may cause a convulsion shortly after birth, so that it simulates the picture of cerebral trauma, and the practitioner may be blamed for his allegedly faulty

obstetrics when, in fact, he was not to blame. Hydrocephalus, microcephalus, walnut brain, may all cause convulsions. Children suffering from this type of convulsion often have spastic limbs, and the condition is nowadays called cerebral palsy. During infancy babies frequently bend forward suddenly, and the arms fly out on each side. This is the so-called salaam type of epilepsy, or petit mal, which may be repeated many times a day. These children are often plunged into status epilepticus when they are attacked by some minor infection, such as a sore throat or a cold.

Cerebral Haemorrhage from Trauma, Asphyxia, and Cerebral Oedema. The child who has had a difficult birth, breech or head presentation with prolonged labour and cord round the neck, is a candidate for cerebral damage. Forceps delivery in a premature infant, or in cases in which the pelvis is small and the head large, may cause a subdural haematoma. In such infants, no convulsions may occur at the time. Only the characteristic shrill cry and pathological alertness of the infant are present to warn us. Any sudden noise makes this baby start or jump, and handling causes the baby an abnormal upset. On the other hand, the baby may twitch from the first, and it will be noticed that it fails to suck, cry, or breathe as well as it should. The fontanelle may bulge. A lumbar puncture may show blood in the cerebrospinal fluid. A cerebral tap, however, may demonstrate a subdural haematoma and this should be dealt with by repeated tapplings, and finally by an operation which will dissect out the clot and sac. Subdural haematoma may not, however, show itself for many weeks or months, and then the onset of hydrocephalus and convulsions suggests that diagnosis.

Cerebral Infections. When called to a case of convulsions in an infant or child, we should always ask ourselves, 'Has this child got meningitis or encephalitis?' The taking of the temperature is helpful, as in true epilepsy there is, as a rule, no fever. Often a previous history of similar convulsions in a febrile child will suggest the correct diagnosis, but it may be necessary to perform lumbar puncture before we can be certain. An examination of the ears may reveal an acute infection, or there may be a

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mastoid infection which could spread to the meninges. A purpuric rash would suggest meningococcal meningitis. The presence of a stiff neck suggests meningitis or meningism, and only a lumbar puncture will indicate which it is.

In tuberculous meningitis the convulsions occur, as a rule, late in the disease, but occasionally this form of meningitis is ushered in by a fit.

Infections Outside the Nervous System. The commonest cause of convulsions in the first three or four years of life is an infection in the ear, throat, chest or kidney, or the onset of one of the acute exanthemata, such as measles, chickenpox, scarlet fever, or mumps. Some children tend to have a convulsion with any high fever, when it takes the place of a rigor. It has been suggested that the infection alters the blood chemistry which, in turn, causes a rise in cerebrospinal fluid pressure, causing the convulsion. Certainly the cerebrospinal fluid pressure is raised in such cases whatever the cause. In a series of cases studied, it was found that the average number of convulsions was five, and that these recurred with each bout of infection, at about three or four month intervals.

It is curious how seldom the onset of the infection is suspected, and the first evidence of it is the sudden convulsion. The worry over this episode often causes the underlying infection to be repeatedly overlooked, and to remain unsuspected. A careful taking of the temperature, and a physical examination will usually reveal the cause, and relieve the minds of the anxious parents. It also gives the practitioner a chance to treat the cause rather than the symptom. As a rule such cases are not presented beyond the age of 4 or 5 years, and no sequelae, such as mental defect or paralysis, are found later on.

On the other hand, a backward child with some cerebral lesion also tends to have symptomatic convulsions with a passing infection, so that a knowledge of the child's state of health before the convulsions is necessary if one is to rule out this situation. There are, however, some cases in which symptomatic convulsions have been diagnosed and repeated episodes have occurred, which later prove to have an unsuspected cerebral origin, and the good prognosis given at the time proves unfounded. Fortunately these cases are rare.

Asphyxia. The classical example of asphyxia is seen in the child with breath-holding convulsions. Such children, when aged about 1 year or 18 months, get into a rage or temper when they fall, when a toy is removed from their hands, when they are put on their pot, or are being dressed; then they hold their breath. The sequence of events is well known. First there is steadily increasing cyanosis; then the child becomes unconscious and stiff with the eyes

wide open and congested. The child may now twitch for a moment, then relaxes. In a minute or two the child awakens, looks about in a dazed fashion, gets up and runs about as before, apparently none the worse for the episode. This type of convulsion may happen several times a day; the parents are afraid to cross or discipline the child, who in turn becomes more and more exacting. Sedatives have no real effect. Such children are usually 'only' children, or the youngest of a grown-up family, or adopted children. They are frequently spoiled or undisciplined, and have not been taught self-control. The treatment appears to be a training in self-control. Once the parents understand that the child will not die in an attack, which can be aborted by the sudden application of a cold sponge or cloth applied to the face at the very beginning, they soon discipline the child and a cure results.

You may ask why such children are able to hold their breath; have they an enlarged thymus? Are they rachitic? The answer to both questions is no, but I do not know the pathology of cases of this kind.

In the spasms of whooping cough a convulsion of this type may occur, but, on the other hand, actual cerebral haemorrhage may also occur with a resulting mental change or permanent hemiplegia afterwards. Fortunately the majority of children recover completely.

Tetany or Spasmophilia. This may be termed 'nervous rickets' or 'low calcium rickets' as opposed to the low phosphorus rickets seen in bony rickets. Both sorts of rickets may, of course, be present at the same time. The low blood calcium level makes the nervous system very excitable, and increases the conductivity of the peripheral nerves. There is often a spasm of the glottis with laryngismus stridulus accompanying the convulsion. The exciting cause may be the onset of an infection, the shock of an accident, or a digestive upset. It is claimed that the cutting of a tooth, phimosis, or worms may start an attack.

The treatment for tetany or spasmophilia is the intravenous or intramuscular administration of calcium chloride in doses of from 3 to 6 grains. Vitamin D, as cod-liver oil or one of the fish liver oil preparations, together with real or artificial sunshine, and a good diet are also necessary. Calcium gluconate may be given by the mouth in daily drachm doses with benefit. In addition, chloral hydrate is indicated in sufficient doses to produce sedation.

Rare Causes of Convulsions

I have discussed the commoner causes of convulsions and we now come to the rarer causes.

Lead Encephalopathy. This is the commonest

cause of convulsions in infancy or childhood due to poisoning (Brown and Tisdall*). The nibbling of paint on cots and toys and crayons may continue from two to four months before symptoms occur, but if the diet is rich in calcium in the form of plenty of milk, the symptoms develop slowly, because calcium produces an insoluble salt with lead. An acute infection may precipitate symptoms, which consist of irritability, abdominal pain, anorexia, constipation, vomiting, and mental retardation. Later, convulsions occur and may last from 12 to 36 hours or may occur at intervals over weeks. The diagnosis is made by radiography of the long bones and ribs, where a white line is found at the growing ends and at the costochondral junctions. Blood smears show punctate basophilia or stippling, and an examination of the urine shows an increase of lead.

The treatment is to administer calcium by mouth or intravenously and is best done by means of calcium lactate or calcium gluconate. Vitamin D will help to fix the lead and prevent symptoms. In the British Isles this must be a very rare cause of convulsions, as I do not recall seeing a single case there, and in nearly two years' residence in Vancouver, I have seen no case diagnosed as lead encephalopathy.

Uraemia. This disease should be seriously considered if the convulsion continues any length of time. An examination of the urine is necessary. A history suggesting previous nephritis, the finding of retinal haemorrhages or exudate, would all suggest the possibility of uraemia. A blood urea test would confirm the diagnosis.

Tetanus. This is a rare cause of convulsions, and as a rule there is no loss of consciousness. Handling or any slight stimulus produces a generalized spasm and the characteristic facies (risus sardonicus) and opisthotonos, and as a result the diagnosis is comparatively simple.

Measles and Chickenpox Encephalitis and Mumps, and Meningitis. These may all be ushered in by a convulsion, but the diagnosis should not be difficult because of the preceding diseases.

Hypoglycaemic Convulsions. Convulsions of this type are reported in normal individuals whose blood sugar level is too low. They are said to occur in the night or very early morning when the blood sugar level is at its lowest; such children can be cured by doses of glucose at bedtime.

Diabetes. In diabetics, attacks of hypoglycaemia occur after an overdose of insulin, and are ushered in by faintness, sweating, mental confusion, and tremors. It is not difficult to make the correct

diagnosis when there is a previous history of diabetes.

Diarrhoea. As a termination in cases of severe diarrhoea, convulsions may occur and are probably due to dehydration with insufficient elimination of urea and other body breakdown products. The treatment is saline and glucose given intravenously.

Poisoning. Poisons such as strychnine will cause convulsions.

Treatment of the Convulsive State

Treatment involves the appreciation and treatment of the underlying cause of the convulsion, and the treatment of the convulsion itself by sedation and lumbar puncture.

A thorough physical examination which reveals an infection of the throat, ears, lungs, or kidneys and bladder calls immediately for appropriate antibiotic or other treatment. Where cerebral haemorrhage is suspected, it may often be best to disturb the infant as little as possible until the state of shock is over. Later a lumbar puncture or a cerebral tap can be undertaken. In cerebral infections the sulphonamide drugs and antibiotics will be given.

How should the convulsion itself be treated? What can the parents be told to do while the doctor is on the way to help them? What about the time-honoured mustard bath? Clearly the parents must be given something to do to keep them occupied. It is doubtful, if the child has a temperature of 104°, whether a mustard bath or even a warm bath is a good thing, but if the child feels feverish, tepid sponging, and the application of an ice pack to the head are good therapeutic procedures. In cases where there is no fever a hot mustard bath is indicated, and will help to relax the child.

A saline or weak soap and water enema should be given. The temperature should be taken, and something placed between the teeth to prevent the child from biting the tongue.

Sedation should be begun. Sodium phenobarbital may be given in doses of $\frac{1}{2}$ to $\frac{3}{4}$ grain subcutaneously in infants. Chloral hydrate may be given in doses of four to eight grains rectally. A general anaesthetic of chloroform or ether may be used. Magnesium sulphate may be given intramuscularly (20 ml. of an 8% solution injected into muscles of the thigh or buttock). Other sedatives which are useful are seconal or amytal, and from $\frac{3}{4}$ to 5 grains should be given by mouth or rectum depending upon the age of the child. Avertin may be given rectally in doses of 0.1 ml. of avertin fluid per kg. body weight, made up to a 2½% solution in distilled water. Paraldehyde (four minims per lb. body weight or 1 dr. per 14 lb.) is administered

* Brown, A. and Tisdall, F. (1949). 'Common Procedures in the Practice of Paediatrics' Toronto.

rectally to infants and children in ten times its volume of normal saline.

If convulsions continue, a lumbar puncture should be performed, and 10 to 15 ml. of cerebrospinal fluid withdrawn.

Epilepsy

Let us now turn to epilepsy of the idiopathic type. By this I mean cases with major or minor convulsions for which no adequate cause can be found. This definition excludes the obvious hydrocephalic, microcephalic, and birth trauma cases.

In very young children it is extremely difficult to differentiate early epileptic cases from those with the symptomatic convulsions we have just been discussing, especially if it is the first convulsion.

Epileptic seizures are not common in babies, but by 6 years of age they begin to show up rapidly, and by 10 years, one-half of all epileptics have had their first attack. Although often we cannot find a true organic basis for the fits, recent investigations with the electroencephalogram have proved many cases to have an area of scarring or old degeneration or under-development, or some early tumour formation, and these may be proved at operation. Electric potentials are present in the living brain cortex, and they arise from the nerve cells of the cortex. In infants these potentials are slow, say under 6 per second, but in children, aged 3 years, they have risen to 7 per second. They reach 10 per second at 10 to 15 years, and this is the adult pattern. With any disturbance in brain function, such as that caused by an expanding lesion, brain degeneration, or epilepsy, slow waves make their appearance, and may appear in hyperventilation or over-breathing. Behaviour problem children often show cerebral asymmetry. Generally speaking, slow frequency waves and bilateral asymmetry found in those above infancy suggest functional abnormality of the brain, but no sweeping conclusions can be drawn.

Large numbers of convulsions cause punctate haemorrhages into the brain, and ultimately cerebral sclerosis and softening may occur.

The picture of a fit may be divided into the aura, the loss of consciousness when the child often falls down, the convulsion which follows with its tonic and clonic phase, and finally relaxation and sleep. The loss of sphincter control is frequent.

In a petit mal attack, these 'absent moments', or little turns, may last a moment or two only. There may be several dozen in the day. The sequelae of attacks may be mental confusion, transitory hemiplegia, or status epilepticus.

Psychomotor Attacks. Some children get temper tantrums and screaming attacks which are either present by themselves or interspersed between

grand mal and petit mal, or which take the place of the big or little attacks. One should mention that attacks at night are on the whole more common than those in the day time.

Treatment of Epilepsy. The following drugs are particularly useful in each type of convulsion. In cases of grand mal, or convulsive seizures, phenobarbital, dilantin (epanutin), mesontoin, mebaral, or dilantin and bromides should be used. The use of tridione is contra-indicated.

In psychomotor seizures dilantin is the only drug which is generally useful, and may be combined with tridione. Phenobarbital is disappointing. Mesontoin may be helpful.

In cases of petit mal, phenobarbital, mebaral, glutamic acid, amphetamine sulphate (benzedrine), and dilantin have all been used, but tridione is the drug of choice.

Grand and petit mal should be treated as grand mal.

In status epilepticus phenobarbitone (sodium luminal) should be given by injection, and paraldehyde rectally or intramuscularly.

It should be noted that bromides are not now used. Phenobarbital (phenylethylbarbituric acid) may produce a rash like that of scarlet fever, and drowsiness. It is dispensed in tablets of $\frac{1}{4}$, $\frac{1}{2}$, and $1\frac{1}{2}$ grains, and in an elixir, one teaspoonful of which contains $\frac{1}{4}$ grain. The sodium salt is used for injection. The physician should begin with $\frac{1}{4}$ grain, and work up to twice or three times this dose.

Methylethylphenylbarbituric acid ('mebaral', or in Europe 'prominal') is a substitute for phenobarbital and is dispensed in tablets of $\frac{1}{4}$ or 3 grains. The dose is one to three. Diphenylhydantoin sodium (phenytoin sodium) or dilantin sodium ('epanutin') is suitable for use in psychomotor seizures. The complications which can be caused by this drug are muscular incoordination, nystagmus, double vision, unsteady gait, giddiness, a measles-like rash. It is dispensed in sealed capsules of $\frac{1}{2}$ or $1\frac{1}{2}$ grains. Children under 2 years should be given a dose of 1-3 grains. Phenobarbital may be given along with dilantin.

Methylphenylhydantoin ('mesontoin') is reported to be superior to dilantin, especially if the patient does not tolerate dilantin. It does not produce ataxia, but skin rashes, and possibly aplastic anaemia.

Trimethyloxazolidinidione ('tridione') is suitable for petit mal, but not for grand mal. In about one-third of the cases, petit mal seizures disappear after its use, another third are much improved, and 17% are not helped. Often attacks do not return after medication. The drug should be given for as short a time as possible. The electroencephalogram

may become normal and then the drug can be stopped. Side effects of this drug include a generalized rash like measles, and, when this occurs, the drug should be stopped until the rash disappears. Older children may get photophobia, and a glare effect in sunshine. The most serious effect is aplastic anaemia. The leucopenia is a neutropenia. The blood should be examined monthly. Anaemia appears late. Deaths have been reported, usually in older children. An infant may be given one of the $4\frac{1}{2}$ grain capsules daily in a spoonful of food. From 2 to 4 years, two capsules should be given a day; for children over 5, three capsules a day. This amount may need to be doubled to get good results.

Treatment Other than by Drugs. It is a clinical observation that seizures are relatively infrequent when the patient is physically or mentally busy. The explanation given is that with activity the CO_2 and lactic acid content of the brain cells rises, and its alkalinity is reduced. The more acid the brain, the less irritable are the nerves. A ketogenic diet is one which contains three or four times as much fat as protein and carbohydrate combined. Ketone bodies inhibit attacks. Limitation of fluid is also associated with the use of the diet, but both have fallen into disuse since better drugs have become available.

Surgery is not usually of any use.

Psychotherapy is a very useful supportive therapy and is most important. The convulsions affect both the child and the parents psychologically and it is important to be optimistic. Exercise and activities, for example, swimming and bicycling, should, however, be restricted where the safety or the rights of others are involved. Feelings of guilt on the part of the parents because of possible hereditary causes of the child's illness must be combated, and the family and patient should be advised to live as if this disorder did not exist. The child's mind should be kept thoroughly occupied.

The gloomy prognosis usually given is not justified, according to Lennox.* It is impossible in an individual case, particularly if the child is very young, to forecast the mental state the child will attain in adolescence. Since this appears to be a fact, it is much better to give the parents a most guarded outlook for the future except in the case of children whose mentality is obviously grossly affected. Also, it used to be taught that there was steady mental deterioration, but one must conclude that this is now quite incorrect.

* William G. Lennox (1948). A monograph on *Therapeutic Agents in the Treatment of Epileptiform Seizures* in 'Advances in Pediatrics,' Vol. 3, pp. 91-130.