



Therapeutic monitoring in patients with epilepsy

– Principles and case report about the control of seizure activity by intravenous valproate (*Orfiril® injection solution*)

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H. Stefan

Principles of epilepsy treatment

The aim of treatment for epilepsies is to control seizures without causing adverse effects by reaching the best possible quality of life. A satisfactory suppression of seizures is possible in 60 – 70% of patients. In patients with incomplete seizure control it is of importance to achieve seizure reduction and to diminish severity of seizures. The choice of the optimal drug is not only determined by seizure control but also by potential adverse effects. A disposition and accompanying diseases are varying individually. The choice of the optimised drug, titration rate and dosage needs to be individualised to achieve optimal effectiveness. The number of time-adjusted daily application and an optimised combination of anti-epileptic drugs is important too. The combination of antiepileptic drugs bears a higher risk of side effects which might be influenced in part on the pharmacokinetic or pharmacodynamic properties of the drug.

Regarding today's numerous range of different antiepileptic drugs, the following indicators are of high significance:

- an optimal efficacy in the individual epileptic syndrome
- tolerability
- interactions
- dosage.

Since 30 – 40% of the patients suffering from epilepsy do not re-

spond satisfactorily to a first anticonvulsant treatment, the question of further diagnostic possibilities with respect to a successful therapy arises.

Differential diagnosis and classification of seizures and epilepsies

As seizures in general occur within a short period consequently a systematic observation is lacking and because of the patient's clouding of consciousness one is dependent on the reports of an observing person. Thus, considerable problems arise by incorrect and false descriptions (*Mannan and Wieshmann, 2003*). In 20 – 25% of the patients non-epileptic seizures are classified as epilepsy and vice versa. They are mostly confounded with synopies, psychogenic seizures, parasomnia, migraine or transitory ischemic attacks. Those 15 – 50% of patients are falsely treated with antiepileptic drugs. In a prospective controlled trial at our center in which clearly documented seizures by means of video-EEG have been compared with the information obtained from the patients immediately after seizure occurrence and some time later, showed that in 138 seizures only 49,3% could clearly be reported by the patients, 44% remained completely unnoticed.

The routine way to the diagnosis of an epileptic disease should be

gone step by step. After identification whether epileptic or non-epileptic seizures are evident then a first step is the coordination according to the international classification of seizures and epileptic syndromes. Different phases of the epileptic seizure as well as postictal deficits can be recorded using the nucleus-shell-model (*Stefan et al. 2003*). Considering etiology, age related circumstances and the course of epilepsy more complex entities can be determined susceptible to prognostic hints. Therefore we have to distinguish between the classification of epileptic seizures and the classification of epileptic syndromes. The knowledge about the epileptic syndrome is of high importance for a prognostic opinion and the choice of a medical or surgical treatment (*Stefan, 1999*).

As example for such a proceeding the examination regarding efficacy and time related start of the effect of valproic acid (e.g. *Orfiril® injection solution*) in difficult to treat focal epilepsies is described.

Regardless efficacy and tolerability of new antiepileptic drugs the effect of drug withdrawal can be recorded with the TISA method in an objective way. Here, carbamazepine and lamotrigine strongly *tend more* to the occurrence of secondary generalized tonic clonic seizures compared to valproate (*Wang-Tilz et al. 2005*).

The selection of anticonvulsants for different focal or generalized epilepsies is shown in the latest report of licensing status of approval (Fig. 1).

Examination methods for diagnostics and therapy

As an additional most often used examination tool in routine diagnostics besides the wake-/sleep-EEG is the MRI. For an intensive monitoring with long-term recordings the mobile long-term-EEG recording (MLE) and the simultaneous video EEG recording (SDA) can be employed including serum concentration measurements of the taken medication (Tab. 1).

An assessment of the gain of information regarding the different examination methods such as routine EEG, ictal routine EEG, long-term video EEG for therapeutic monitoring in patients with epilepsies is shown in Table 2. In this table it is demonstrated that in difficult to treat epilepsies the supervision of the diagnosis by means of video EEG monitoring and an improved classification may lead to better treatment results (Tab. 2).

The reasons for this are

1. an objective documentation of seizure events
2. their coordination in epileptic and non-epileptic seizures
3. as well as their classification and also frequency of occurrence.

	FOCAL EPILEPSY			GENERALIZED EPILEPSY			
	simple SF	complex CF	sec.gen. TK	TC	Absence	Myoclonus	LGS
Carbamazepine (CBZ), mono	>4						
Oxcarbazepine (OXC), mono	>6						
Valproic acid (VPA), mono							
Lamotrigine (LTG), mono	>12 add on >2						
Topiramate (TPM), mono	>2						
Gabapentin (GBP), mono	>12 add on >3						
Tiagabine (TGB)	>12						
Levetiracetam (LEV), mono	mono >16 add on >4			add on >12			JME ≥12 add on
Pregabalin (PGB)	>18						
Zonisamide (ZNS)	>18						
Rufinamid (RUF)	LGS add on >4						

Fig. 1: The selection of anticonvulsants for different focal or generalized epilepsies is shown in the latest report of licensing status of approval.

As 40 – 50% of patients are unaware of their seizures while sleeping therefore long-term recordings for 24 hours or for several days may be helpful. As to

our experiences one can gain with a continuous 72 hours long-term video EEG monitoring 60 – 79% new pioneering results with respect to an optimizing treatment.

Table 2: It is demonstrated that in difficult to treat epilepsies the supervision of the diagnosis by means of video EEG monitoring and an improved classification may lead to better treatment results.

Routine-EEG / intensive-(video-EEG)-monitoring	Detection of epileptiform EEG activity	Knowledge gain
Routine-EEG	+	40%
Routine-EEG ictal	+	2,5 – 7%
Long-term(video/EEG) ictal	+	50 – 70%
New classification		48 – 84%
Seizure reduction		60 – 70%
Clinical signs		67 – 72%

Table 1: Main Indications for EEG measurement

1.	Identification of epileptic activity (focal, generalized; markeness)
2.	Initial data for control of therapy (ground activity, unspecific source localization and epileptiformactivity, the latter especially in generalized regular bilateral-synchronous spike-wave activity)
3.	Psychic symptom (intoxication, psychosis, other psychic changes)
4.	Difficult to control epilepsy, changes in results and symptomes, seizure frequency, pharmacoresistance
5.	Reduction of medication

Testing of antiepileptic drugs

A new sensitive and objective examination method is the so called "therapeutic intensive seizure analysis" (TISA, Stefan et al., 2004). These analysis helps to quantify objective data, e.g. seizure frequency and seizure severity. This can lead to significant results even with a minor

number of patients. The study design allows the comparison of a substance with placebo or with different dosages of a drug. This objective documentation of seizures can prove the superiority of a substance compared to another or the stronger effectivity of one dosage.

In addition to an objective measurement of effectivity by quantifying seizure activity with respect to frequency, duration and severity neuropsychological testing can repeatedly be carried out during monitoring and being correlated with the serum concentration of the applied substance. Other investigations showed in comparison of 100 mg to 200 mg topiramate a significantly better efficacy of 200 mg. The parenteral application of the MHD of oxcarbazepine also showed a significant effect.

Computer supported seizure detection in emergency cases (status epilepticus)

In the field of intensive medicine the EEG can deliver essential ad-

ditional information in the treatment course of a status epilepticus. In a first phase of the tonic clonic seizure there is a dominance of motoric manifestations which, however, can distinctly regress in its sequence so that in the end the status is only to be identified as non-convulsive "electrical" status. This requires continuous long-term EEG recordings. The recording of seizure frequency and duration of a non-convulsive status is only to objectify by carrying out long-term EEG monitoring. For a targeted conduction of therapy in the course of a status epilepticus the epileptic activity in long-term EEG can be an important indicator.

Various examinations point out, that persisting epileptic activity can be associated with an unfavourable treatment effect or elevated mortality rate (*de Lorenzo et al. 1998, Jaitly et al. 1997*). An important task for the intensive EEG monitoring is to clarify which correlation exists between epileptic activity and prognosis

regarding seizure control and functional recovery. Appropriate methods of the computer supported analysis can today be applied in quantifying seizure activity (frequency, severity, duration) in the long-term course (*Hopfengärtner et al. 2007*). Of great importance is that these results are available for the physician within short (*Fig. 2*).

Neuropsychological examinations during therapeutic monitoring

Cognitive side effects of anti-epileptic drugs today can be recorded with an easy to handle computer supported test system (*Pauli et al. 2007*).

This computer supported cognitive emotional testing in epilepsy (CCTE) is mainly be employed in first anticonvulsant applications, change in medication and combination therapy as well as in epilepsy in the elderly in order to fix an individual and optimal well-tolerated dosage.

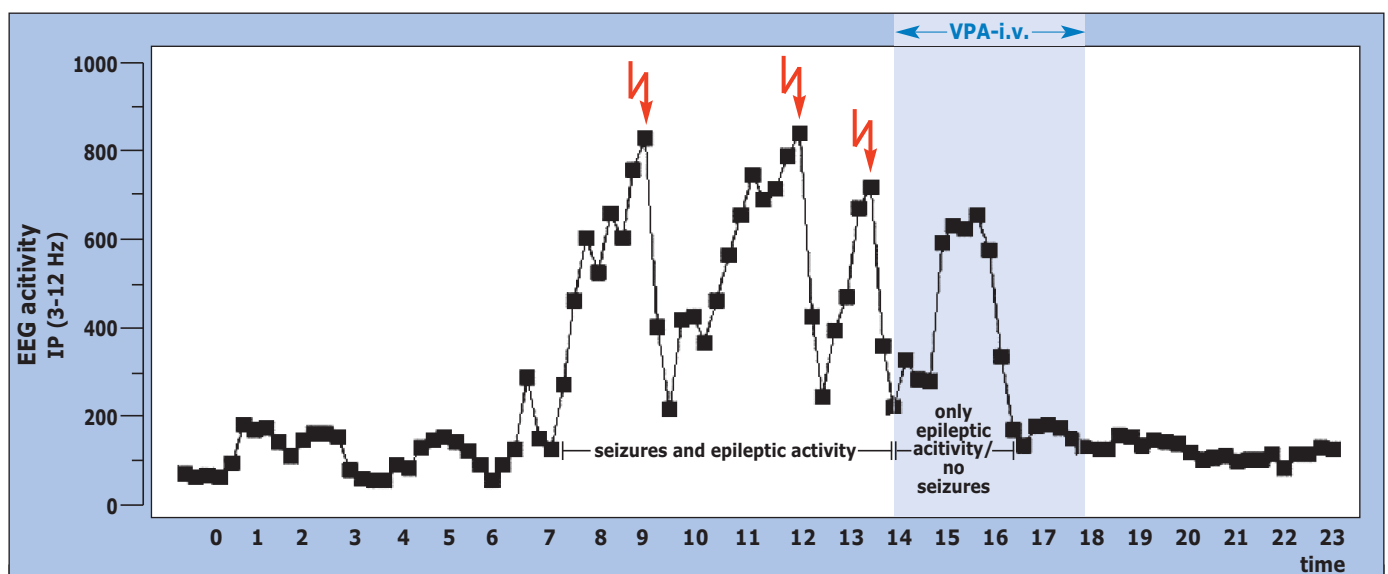


Fig. 2: Long term EEG of a 30 year old female patient with idiopathic generalized epilepsy. Three tonic clonic seizures, a none convulsive status, controlled by 900 mg intravenous valproate (**Orfiril® injection solution**) is demonstrated in the figure. The curve shows the course of the epileptic activity in long-term EEG. The quantification of long-term EEG activity (*by the method of Hopfengärtner et al. 2007*) was used to guide valproate treatment.

⚡ Tonic clonic seizure

Conclusion

In summary, by aid of the TISA technique a better computer supported seizure detection (see e.g. in figure 2: application of **Orfiril® injection solution** in a patient with repetitive seizures) and cognitive emotional testing we have methods at our hands providing practical decision aids which we did not have formerly. In addition to seizure control cognitive changes can be perceived earlier and the individual dosage adjusted accordingly. This could be an important precondition for more easy to handle in- and outpatient treatment.

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Orfiril® i.v. is also marketed under the following brands:

- **Episenta®** in the UK
- **Diplexil®** in Portugal
- **Valproate Mylan** in Belgium

In some countries Orfiril® 100 mg/ml injection solution with ampoules of 10 ml (1000 mg valproate) are also available.

ORFIRIL® I.V. - BASIC INFORMATION

Orfiril® 100 mg/ml solution for injection.

Presentation: 1 ml solution for injection contains 100 mg sodium valproate. Other ingredients: Disodium edetate, hydrochloric acid, sodium hydroxide, water for injections.

Indications: Epileptic patients in whom oral sodium valproate therapy is not possible. Primarily generalised seizures in the form of absence (petit-mal) seizures, myoclonic and tonic-clonic seizures. Alone or combined with other antiepileptics for other types of seizures, e.g. simple or complex focal seizures and focal seizures with secondary generalisation.

Contra-indications: Hypersensitivity to valproate/other ingredients, previous or current liver disease and/or manifest severe hepatic/pancreatic dysfunction, family history of liver disease, fatal liver dysfunction in a sibling during valproate therapy, porphyria.

Warnings and Precautions: Use with special care in: young children and children on multiple anticonvulsant therapy, bone marrow damage, children and adolescents with multiple disabilities and severe epilepsy, blood clotting disorders or thrombocytopenia, congenital enzyme deficiency diseases, renal failure and hypoproteinaemia, lupus erythematosus. Use in young children only in exceptional cases (special caution, strict benefit-risk assessment, if possible as monotherapy).

Pregnancy/lactation: Increased risk of malformations (including neural tube defects), particularly on exposure in 1st trimester and start of 2nd and on combined therapy. Potentially increased risk of developmental delay. Administer in the lowest seizure-controlling dose and, wherever possible, as monotherapy. Advise women of child-bearing age of need to plan and monitor pregnancy before beginning treatment. Breast-feeding possible.

Side effects: Side effects attributable to use of Orfiril® 100 mg/ml solution for injection include all those associated with oral forms of valproate. On parenteral use, burning at injection site and dizziness can occur. Commonest side effects are gastrointestinal disorders (in about 20% of patients). Severe (even fatal) liver damage, especially in children given high doses or on multiple anticonvulsant therapy, has been observed. Blood and lymphatic system: common: thrombocytopenia, leucopenia; uncommon: haemorrhage; very rare: bone marrow suppression, reduction in fibrinogen and/or clotting factor VIII, impaired platelet aggregation, increased bleeding time, lympho-, neutro-, pancytopenia, anaemia. Immune system: rare: lupus erythematosus, vasculitis; unknown frequency: allergic reactions. Endocrine system: rare: hyperandrogenism. Metabolism and nutrition: common: hyperammonaemia, weight gain or loss, appetite increased or decreased; rare: hyperinsulinaemia, reduced levels of insulin-like growth factor-binding protein I, oedema, hypothermia; very rare: altered thyroid function tests. Psychiatric: rare: irritability, hallucinations, confusion. Nervous system: common: drowsiness, tremor, paraesthesia; uncommon: transient coma (in some cases with increased seizure frequency); rare: headache, hyperactivity, spasticity, ataxia, stupor, hypersalivation;

very rare: encephalopathy(1), dementia associated with cerebral atrophy, parkinsonian syndrome (reversible). Gastrointestinal tract: very common: stomach pains, nausea, vomiting; rare: diarrhoea, pancreatitis. Liver and gall-bladder: common: changes in liver enzymes; rare: severe liver damage(2). Skin and subcutaneous tissue: common: transient hair loss, hair thinning, curly hair if regrowth; rare: rash, erythema multiforme; very rare: Stevens-Johnson syndrome, Lyell syndrome. Kidneys and urogenital tract: very rare: Fanconi syndrome, enuresis in children. Reproductive system and breasts: common: amenorrhoea; rare: polycyst. ovaries. General disorders and administration site conditions: rare: inflammation at injection site; unknown frequency: tissue disorders after erroneous intra-arterial or perivenous injection, dizziness. (1) Rarely shortly after use of valproic acid-containing drugs: encephalopathy (pathogenesis unclear, reversible after discontinuation); in some cases with hyperammonaemia, as well as increased phenobarbital levels on combination with phenobarbital. In isolated cases - especially with higher doses or in combined therapy with other antiepileptics, chronic encephalopathy with neurological symptoms and disorders of higher cortical functions, aetiology unclear.

(2) Particular attention must be paid to signs of liver damage: loss of seizure control characterised by renewed occurrence or increase in seizures, physical weakness, loss of appetite, nausea or repeated vomiting, unclear epi-gastric symptoms, generalised or local oedema, hearing loss, disturbances of consciousness with confusion, restlessness and movement disorders. Very rarely damage to pancreas with similar clinical features also observed. Monitor infants and young children carefully. If above symptoms persistent or severe, in addition to thorough clinical examination, laboratory investigations required.

Other warnings: Inspect diluted solutions before use. Use only clear and particle-free solutions. Do not add other drugs to solution for injection. Reaction capacity can be impaired.

Interactions, dosage recommendations and further warnings: See Information for Healthcare Professionals and Package Leaflet.

Legal category: POM.

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