Antiepileptic drugs and psychopathology of epilepsy: an update

Marco Mula, Francesco Monaco
Department of Neurology, Amedeo Avogadro University, Novara, Italy
Received January 15, 2008; Accepted January 9, 2009

ABSTRACT – Anti-epileptic drugs (AEDs) continue to be the mainstay of epilepsy treatment, but the benefits of seizure control need to be weighed carefully against possible adverse effects, which can include behavioral problems and psychiatric disorders. In this paper, the associations between AEDs and psychosis, depression and behavioral changes are reviewed. The concept of forced normalization and its clinical counterpart, alternative psychosis, are also discussed. Depression seems to be linked with AEDs potentiating GABAergic neurotransmission in patients with limbic system abnormalities such as hippocampal sclerosis. Psychoses have been described as associated with several of the new AEDs, and they are often seen in a setting in which previously refractory patients suddenly become seizure-free. In general terms, the use of AEDs in monotherapy, adopting slow titration schedules and low doses when possible, can significantly reduce the occurrence of behavioral adverse effects. A previous history of psychiatric disorder or a familial predisposition are important risk factors and should be always considered when choosing the appropriate AED.

Key words: epilepsy, anticonvulsant drugs, depression, psychosis, adverse effects, behavior, mood, AEDs

Psychopathology in epilepsy has a multifactorial etiology and anti-epileptic drugs (AEDs) constitute only one of many determinants that are both neurobiological and psychosocial (table 1). It is often difficult to determine which psychopathological manifestations are due specifically to the drug therapy and which may be due to the many other factors affecting the patient. In theoretical terms, a possible way to determine whether a drug is causing an adverse event would be to withdraw the drug, then rechallenge with it and observe the outcome (Mattson 2004); however, such studies have ethical limitations.

The psychotropic potential of AEDs can be divided into those that are positive and those that are negative. Our knowledge about negative psychotropic properties of AEDs is not based on standardized or defined diagnostic criteria. With respect to the older generation of compounds, such as barbiturates, phenytoin or carbamazepine, there are no systematic data, while for the new generation of drugs, there are data from drug trials that are, however, designed to test anti-seizure efficacy. Knowledge of the psychopathological phenomenology of psychiatric adverse effects of AEDs as well as the severity, time-course

Correspondence:
Dr M. Mula
Division of Neurology,
Amedeo Avogadro University,
C.so Mazzini, 18,
Novara 28100, Italy
<marco.mula@med.unipmn.it>
and relationship to seizures of such adverse effects remains incomplete. Ketter et al. (1999), reviewing positive and negative psychotropic effects of AEDs, suggested that two categories of drugs could be identified on the basis of their predominant psychotropic profile. Sedating drugs are characterized by adverse effects such as fatigue, cognitive slowing, and weight gain; these drugs usually potentiate gamma amino butyric acid (GABA) inhibitory neurotransmission (table 2). On the other hand, there are activating drugs with anxiogenic and antidepressant properties that attenuate glutamate excitatory neurotransmission. In the first group, there are drugs such as barbiturates, valproate, gabapentin, tiagabine and vigabatrin, while in the second group there are felbamate and lamotrigine. Topiramate can be considered a molecule with a mixed profile. This paradigm proposed by Ketter is straightforward, but in patients with epilepsy, the epilepsy itself complicates the situation. The psychotropic effects of AEDs are probably related both to direct and indirect mechanisms (table 3). The former represent the main properties of the drug and can be easily predicted using the theoretical framework suggested by Ketter. On the other hand, the psychopathology associated with an AED may also result from the effect of the drug on the epilepsy itself. Some phenomena, such as forced normalization or post-ictal psychosis, may be the result of AED changes altering the control of the seizures, without being related to a specific drug: any drug that resulted in the same alteration in seizure control in these patients would have resulted in the same psychiatric disorder. Factors such as the severity of the epilepsy or the presence of limbic system abnormalities may be of relevance. A number of good publications have recently reviewed the positive and negative psychotropic potential of AEDs in patients with epilepsy (Gilliam and Santos 2006, Ettinger 2006). In this paper, we aim to review the major psychiatric syndromes described as treatment-emergent adverse effects of AEDs in patients with epilepsy, in a clinical context, discussing possible mechan-

<table>
<thead>
<tr>
<th>Table 1. Causes of psychiatric problems in patients with epilepsy.</th>
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<tbody>
<tr>
<td><strong>(1) Patient-related</strong></td>
</tr>
<tr>
<td>- Gender</td>
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<tr>
<td>- Premorbid personality</td>
</tr>
<tr>
<td>- Temperament and character features</td>
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<tr>
<td><strong>(2) Epilepsy-related</strong></td>
</tr>
<tr>
<td>- Psychological</td>
</tr>
<tr>
<td>- Role of the disease</td>
</tr>
<tr>
<td>- Ongoing social stress and stigma</td>
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<tr>
<td>- Low expectancy of achievement by family or teacher</td>
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<tr>
<td>- Neurophysiological</td>
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<tr>
<td>- Low inhibition levels</td>
</tr>
<tr>
<td>- Channels dysfunctions</td>
</tr>
<tr>
<td>- Anatomical</td>
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<tr>
<td>- Hippocampal shrinking</td>
</tr>
<tr>
<td>- Amygdala hypertrophy</td>
</tr>
<tr>
<td>- Head injury</td>
</tr>
<tr>
<td>- Brain damage (stroke, head injury, infections)</td>
</tr>
<tr>
<td><strong>(3) Anti-epileptic drug-related</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Mechanisms of action of anti-epileptic drugs.</th>
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<tbody>
<tr>
<td>VOC Na blockade</td>
</tr>
<tr>
<td>BDZ</td>
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<td>CBZ</td>
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<td>ETX</td>
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<td>FLB</td>
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<tr>
<td>GBP</td>
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<tr>
<td>LEV</td>
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<tr>
<td>LTG</td>
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<tr>
<td>OXCBZ</td>
</tr>
<tr>
<td>PGB</td>
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<tr>
<td>PHB</td>
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<tr>
<td>PHT</td>
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<tr>
<td>TGB</td>
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<td>TPM</td>
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<tr>
<td>VGB</td>
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<tr>
<td>VPA</td>
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<tr>
<td>ZNM</td>
</tr>
</tbody>
</table>

+ secondary action; ++ primary action; - not described; ? controversial; VOC: voltage opened channel.
The forced normalization phenomenon

Consideration of the concept of forced normalization is essential when discussing the psychiatric adverse effects of AEDs in epilepsy. This concept goes back to the publications of Heinrich Landolt, head of the Swiss Epilepsy Center in Zurich between 1955 and 1971 (Landolt 1958). He reported EEG investigations of patients with epilepsy who had paroxysmal psychiatric disorders, using the newly-introduced EEG, and described a group of patients who had productive psychotic episodes with “forced normalization” of the EEG. In other words, the abnormal EEGs of these patients improved or normalized during the time that they were psychotic. Landolt commented that the introduction of a particular class of drugs, the suximides, led to an increase in the number of cases (Trimble and Schmitz 1998). During the same period, Gibbs (1951) reported intensification of psychiatric disorders in temporal lobe epilepsy when seizures were suppressed with phenacemide, and commented that this could sometimes happen with barbiturates and hydantoins; drug withdrawal could result in reappearance of seizures and resolution of the abnormal mental state (Trimble and Schmitz 1998). Subsequently, Tellenbach (1965) introduced the term “alternative psychosis” for the clinical phenomenon of the reciprocal relationship between abnormal mental states and seizures, which did not, as Landolt’s term did, rely on EEG findings. Since the early observations of Landolt, a number of patients with alternative psychosis have been documented, putting the existence of this phenomenon beyond doubt (Trimble and Schmitz 1998, Krishnamoorthy et al. 2002, Seethalakshmi and Krishnamoorthy 2007a). In many of the series described, the precipitation of the abnormal behavioral state or the psychosis has been linked with the prescription of AEDs, but it is important to note that this phenomenon should not be restricted to drug-induced seizure control. It is likely that in patients who develop de novo psychosis following epilepsy surgery, forced normalization may play such a role. It is interesting to note, in this context, that a case of an alternative psychosis secondary to vagus nerve stimulation has been reported (Gatzonis et al. 2000).

Several psychopathological pictures have been linked to forced normalization, but probably psychosis is the commonest (Krishnamoorthy and Trimble 1999). Wolf (1991) pointed out that several clinical pictures may evolve, not all psychotic, and noted that the development of psychotic symptoms was preceded by premonitory symptoms, especially insomnia, anxiety and social withdrawal. He noted an association with generalized idiopathic epilepsies and the prescription of ethosuximide, again drawing attention to the importance of both generalized seizures and the suximide drugs in the development of these behavioral problems (Wolf and Trimble 1985).
of primidone but less so on carbamazepine. In a similarly designed study, Dodrill and Troupin (1977) compared carbamazepine with phenytoin over a four-month period using a double-blind design in which patients were randomly assigned to one of the two drugs. All subjects were evaluated using the Minnesota Multiphasic Personality Inventory, and scores for every clinical scale favored carbamazepine, with statistically significant differences emerging for the scales related to feelings, attitudes and emotions. In patients with epilepsy treated with a monotherapy regime, Andrews et al. (1986) compared 42 newly referred patients with well-controlled epilepsy using a mood adjunctive checklist. They noted blood levels of carbamazepine to be negatively correlated with measures of anxiety, depression and fatigue. Finally, Robertson et al. (1987) noted that, in a group of patients on polytherapy presenting with a depressive illness, patients taking barbiturates had been significantly more depressed than patients taking carbamazepine. These results could be explained by an association between the barbiturates and depression, an association between carbamazepine and beneficial effects on depression or both of these factors.

As far as new AEDs are concerned, some have been linked with depression as a treatment-emergent adverse effect (table 4), including vigabatrin (Levinson and Devinsky 1999), tiagabine (Trimble et al. 2000) and topiramate (Mula et al. 2003a). It is interesting to note that all of these are GABAergic drugs. Mainly because it was the first of the new drugs to be introduced into clinical practice, vigabatrin has been the most studied (Ring et al. 1993, Thomas et al. 1996). In some patients, the onset of depression was linked with a dramatic control of seizures (a form of forced normalization see Wolf 1984, Trimble and Schmitz 1998), while in others it was unrelated to this. However, in the majority of cases, it appeared to be more common in patients with a history of depression. For example, in the series reported by Thomas et al. (1996), 50% of patients reported a history of a mood disorder. It is of interest that some AEDs seem to be more associated with depression than others, especially those with an activity at the benzodiazepine-GABA receptor. In patients with psychiatric disorders without epilepsy, long-term treatment with benzodiazepines has been reported as provoking depressive symptoms, (Trimble 1996) and withdrawal can provoke a depressive illness (Olajide and Lader 1984). The link between GABA and depression is not easy to explain, but has been used as further evidence for a GABAergic hypothesis for depression. A number of clinical observations and experimental studies have shown that GABAergic mechanisms are involved in the pathogenesis of depression (Petty 1995).

Although topiramate is usually considered to be an antiepileptic drug with a mixed profile, there is some evidence that its GABAergic properties are prominent. Two healthy volunteer studies have demonstrated that treatment with topiramate was associated with the onset of depression and a significant increase in GABAergic inhibitory neurotransmission (Martin et al. 1999, Kuzniecky et al. 2002). Although healthy volunteer studies are often criticized for their lack of relevance to the clinical situation, they are important because it is possible to eliminate the confounding variables related to the underlying epileptic processes. A large, post-marketing survey showed that depression is one of the main, treatment-emergent, psychiatric adverse events during topiramate therapy (Mula et al. 2003a), and relevant clinical correlates were a rapid titration schedule for the drug, a psychiatric history and, probably, a more severe form of epilepsy as suggested by the association with seizure frequency and the

Table 4. Main effects of anticonvulsants on behaviour in patients with epilepsy.

<table>
<thead>
<tr>
<th>AEDs</th>
<th>Treatment-emergent behavioral adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbiturates</td>
<td>Depression, irritability, aggression, impaired cognition and attention, hyperactivity</td>
</tr>
<tr>
<td>Carbamazepine-Oxcarbazepine</td>
<td>Irritability, impaired attention</td>
</tr>
<tr>
<td>Ethosuximide</td>
<td>Behavioral abnormalities, psychosis</td>
</tr>
<tr>
<td>Felbamate</td>
<td>Depression, anxiety, irritability</td>
</tr>
<tr>
<td>Gabapentin</td>
<td>Behavioral problems in children</td>
</tr>
<tr>
<td>Lamotrigine</td>
<td>Insomnia, agitation, emotional lability</td>
</tr>
<tr>
<td>Levetiracetam</td>
<td>Irritability, emotional lability</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>Encephalopathy, depression, impaired attention</td>
</tr>
<tr>
<td>Pregabalin</td>
<td>?</td>
</tr>
<tr>
<td>Tiagabine</td>
<td>Depression (non-convulsive status epilepticus), irritability</td>
</tr>
<tr>
<td>Topiramate</td>
<td>Depression, psychomotor slowing, psychosis, impaired cognition (word-finding and memory)</td>
</tr>
<tr>
<td>Valproate</td>
<td>Encephalopathy, depression</td>
</tr>
<tr>
<td>Vigabatrin</td>
<td>Depression, aggression, psychosis,</td>
</tr>
<tr>
<td>Zonisamide</td>
<td>Agitation, depression, psychosis,</td>
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</tbody>
</table>
presence of tonic-atonic seizures. Interestingly, co-
therapy with lamotrigine was negatively associated, con-
fiming the antidepressant properties of this AED.
In the pathogenesis of AED-induced depressive symp-
toms, a relevant role is played by the limbic structures
(Mula et al. 2003b). There is growing evidence in the lit-
erature that depression might be linked to small hippo-
campal volumes, and this association has been described
not only in patients with epilepsy (Quiske et al. 2000), but
also in patients without epilepsy who have a major
depressive disorder (Bremner et al. 2000, Frodl et al.
2002). A case-control study of patients taking topira-
mate showed that subjects with temporal lobe epilepsy
and hippocampal sclerosis were more likely to develop
depression than those with temporal lobe epilepsy and a
normal MRI, matched for starting dose and titration sched-
ule for topiramate (Mula et al. 2003b). Although patients
with hippocampal sclerosis tend to be affected by more
severe epilepsy, implying that treatment resistance is
likely and that polytherapy may be prescribed, the hippo-
campal sclerosis itself appeared to be the main factor
associated with the occurrence of depression (Mula et
al. 2003b). Folate deficiency is another issue that might be
of relevance regarding AEDs and depression. Patients
on polytherapy are reported to have low serum, red cell or
cerebrospinal fluid folate levels (Reynolds 1976), and this
deficit seems to be even greater in patients with epilepsy
and psychopathology. It is known that folic acid plays a
crucial role in several important central nervous system
transmethylation reactions and is linked to monoamine
metabolism (Trimble 1996). In this regard, it is worth not-
ing that AEDs with a positive impact on mood and behav-
ior, such as carbamazepine or lamotrigine, have minimal
effects on folate levels (Sander and Patsalos 1992). On the
contrary, it is established that barbiturates or phenytoin
treatment can depress serum, red blood cell, or CSF folate
levels in a high proportion of patients (Reynolds 1983).

**Psychoses**

There is a report demonstrating that, in some cases, AED
therapy can be associated with the development of psy-
chosis, with the forced normalization phenomenon being
one of the possible causes (Krishnamoorthy and Trimble
1999). Fischer et al. (1965) and Roger et al. (1968)
described episodes of psychoses during treatment with
ethosuximide, the EEG often reverting to normal.
Another study (Pakalnis et al. 1987) described seven
patients who had no previous psychiatric histories and
whose behavioral problems emerged shortly after starting
or altering AED therapy. Their EEGs, abnormal before
treatment, normalized during the psychotic episodes. All
patients had temporal lobe abnormalities on the EEG, but
only two were on suximides.

With regard to the new AEDs, psychoses have been
noted, as a potential adverse effect, in several cases, sug-
gest that this phenomenon is not drug-specific.
Psychosis has been described with felbamate
(McConnell et al. 1996), tiagabine (Trimble et al. 2000),
topiramate (Mula and Trimble 2003), vigabatrin (Sander
and levetiracetam (Krishnamoorthy et al. 2002). Although
there is no clear evidence for lamotrigine precipitating
psychosis, there are at least some case reports that suggest
that this might be a possibility (Brown 1993, Martin et
al. 1995, Brandt et al. 2007). In general terms, the fre-
cuency of psychoses during AED treatment seems to be in
the region of 1%-2% and all cases described were
difficult-to-treat patients undergoing add-on therapy.
Psychoses associated with vigabatrin have been the most
extensively studied. In the study by Thomas et al. (1996),
30% of patients who developed psychosis during therapy
with vigabatrin had a history of psychosis and 60% of
them became seizure-free. Since these early reports, the
clinical significance of vigabatrin-associated behavioral
problems has been a matter of controversy, and two
meta-analyses have been published (Ferrie et al. 1996,
Levinson and Devinsky 1999). Analyzing seven placebo-
controlled European studies, Ferrie et al. (1996) showed
an overall occurrence of these complications of 3.4% in
the vigabatrin group and 0.6% in the placebo group.
Another meta-analysis of American and non-American,
double-blind studies demonstrated that there is a signifi-
cantly increased risk for psychosis, occurring in 2.5% of
patients treated with vigabatrin compared to 0.3% in the
placebo group (Levinson and Devinsky 1999).
Subsequently, other authors investigated in detail the
main features of psychopathology emerging from AED
treatment and the association with seizure freedom has
been replicated with molecules other than ethosuximide
or vigabatrin (Mula and Trimble 2003).
Placebo-controlled studies of tiagabine showed that the
risk of psychosis was not significantly increased
(SackeIlares et al. 2002). However, the paradoxical pro-
vo members, non-convulsive status epilepticus is a
specific issue reported by different authors (Schapel and
Chadwick 1996) and, in some selected cases, there may
be a differential diagnosis with brief ictal psychotic epi-
sodes (Trimble 1991). In such an event, EEG investiga-
tions are essential.
In general terms, it seems that psychoses with the newer
AEDs occurred in early clinical trials, and to some extent
were a reflection of two factors. First, a dosing schedule
that subsequently appeared to be rapid, or involving
dosages that were too high. Second, the populations stud-
ed were, in many cases, composed largely of patients
with very difficult-to-treat epilepsy and those who had
temporal lobe epilepsy, i.e. the population of patients
that are most susceptible to develop psychoses (Trimble
1991). In other words, certain AEDs appear more likely
to be associated with psychosis, although the latter tends to be seen in those patients who, in any case, are susceptible to developing psychopathology. With the introduction of other powerful drugs in the future, these complications need to be both evaluated and treated.

**Behavioral changes**

The issue of the relationship between epilepsy and behavior has a long history. One line of thought suggests that behavioral changes in epilepsy are a reflection of a temporal lobe, organic brain syndrome, while other authors suggest that they are more a reflection of social stigma or neurological factors, such as recurrent head injury or perinatal disturbances. In any case, AED medication appears to be another important factor.

One of the first studies investigating this issue was that by Reynolds and Travers (1974), who studied 57 adult outpatients with chronic epilepsy for the presence or absence of behavioral changes or psychiatric disorders, looking at serum AED levels. Patients with behavioral problems had significantly higher levels of both phenobarbital and phenytoin than those without, irrespective of seizure frequency. Since that time, there have been many studies on the effects of AEDs on cognitive function or mood, but few of them have specifically investigated the issue of changes in behavior. In general terms, drug-induced behavioral problems, including irritability and aggressive behavior, appear to be more frequent with polytherapy and severe epilepsy, where mental retardation or abnormalities in the limbic system might be present (Trimble 1998). For this reason, the trend towards treating patients with monotherapy, particularly this subgroup of more vulnerable patients, would seem important for the patient’s overall well-being.

A wide spectrum of behavioral changes has been described with different AEDs. For example, some authors have observed that, in children, a conduct disorder, phenomenologically similar to an attention-deficit hyperactivity disorder, may be provoked by a number of AEDs, the most frequently implicated being the barbiturates (Vining et al. 1987, Schmitz 1999). However, there is some debate on this subject, with other authors not demonstrating behavioral problems with phenobarbitone among children (Pal et al. 1998, Pal 2006). A similar psychopathological picture (agitation, excitation, hyperkinesias, and aggressive behavior) has been associated with the prescription of other GABAergic drugs, such as vigabatrin, especially in children with learning disabilities (Bhaumik et al. 1997, Besag 2004).

Aggressive behavior and irritability have been shown to be two of the main treatment-emergent psychiatric adverse effects during therapy with levetiracetam, occurring in about 5% of patients (White et al. 2003). A postmarketing study involving more than 500 patients taking levetiracetam suggested that a subgroup of patients could be biologically vulnerable; a psychiatric history, a history of febrile convulsions and status epilepticus being significant correlates (Mula et al. 2003c). Notably, there are several reports suggesting that status epilepticus and febrile convulsions may play a role in the epileptogenic process. The main hypothesis has involved neuronal loss and synaptic reorganization, mainly in the limbic system. These phenomena might explain the biological vulnerability of this subgroup of patients.

The presence of learning disabilities is another important variable that needs to be considered when discussing AED-related behavioral changes in adult patients with epilepsy. Subjects with learning disabilities or mental retardation have a high incidence of all types of epilepsy (Lhatoo and Sander 2001), and the presence of a psychiatric comorbidity in this special population, represents an important variable complicating the management. An audit study conducted in a tertiary referral epilepsy center described aggressive behavior as one of the main treatment-emergent, psychiatric adverse effects in patients with learning disabilities and epilepsy taking levetiracetam (Mula et al. 2004). Comparing patients with and without psychopathology, a significant association with the same variables previously described in the general population of patients with epilepsy was found, namely a psychiatric history, and a history of febrile convulsions or status epilepticus. However, the prevalence of psychopathology (about 7%) was similar to that described in previous clinical studies involving a general population of patients with epilepsy, suggesting that patients with learning disabilities are not generally more prone to developing psychopathology with levetiracetam, the baseline mental state of the patient and the presence of some abnormalities in the limbic system being the more relevant risk factors.

In clinical practice, it is sometimes difficult to recognize potential psychiatric adverse effects of AEDs in such populations because patients with learning disabilities may be unable to express what they feel, and changes in behavior can be all that is apparent. In general terms, bizarre behavior or the development of suspiciousness or social withdrawal (especially in institutionalized patients) may give some clues to the epileptologist about the occurrence of psychiatric adverse effects of AEDs. Therefore, the clinical evaluation of the mental state is of great value in this special population of patients when choosing the appropriate AED. Finally, if patients who have been very disabled by frequent seizures over a long period of time suddenly become seizure-free and alert, their behavior may become difficult to manage. This condition is also known as the “release phenomenon” (Besag 2004) and can occur with several AEDs that are effective in controlling seizures with a positive impact on alertness and cognition. In this case, the conclusion should not be that the drug has caused the behavioral disturbance, but that the patient may not know how to express his or her new-found ability in an acceptable way. In such circumstances, skilled behavioral input...
can resolve the problem, whereas withdrawal of the AED might return the patient to a disabled state as a result of the frequent seizures.

### Conclusion

The most commonly-reported, psychiatric adverse effects of AEDs are non-specific behavioral problems. Among specific psychiatric diagnoses, depression is the most commonly reported. Psychosis is much less frequent. However, one of the major shortcomings of the literature is the failure of most studies to state what behavioral measures or diagnostic criteria have been used. Several factors are implicated and the risk is likely to be linked to the severity of epilepsy, polytherapy, rapid titration and high dosages of the drugs. It is important to identify clinical phenotypes more at risk of developing psychopathology in order to inform patients and their families, and to ensure that these patients are monitored frequently. In this regard, at least one study has reported that treatment-emergent, psychiatric effects occur in about 8% of patients with drug-resistant epilepsy, probably via a number of mechanisms, such as forced normalization for example, that are not dependent on the specific drug prescribed (Mula et al. 2007). In general terms, a psychiatric history, familial predisposition, and a diagnosis of temporolimbic epilepsy are associated with an increased risk of psychopathology (table 5). Hippocampal sclerosis is associated with a higher risk of depressive symptoms such as depressed mood and mental slowing. In patients with a history of psychosis, abrupt control of seizures with an AED should probably be avoided so as to reduce the risk of alternative psychosis; if a psychosis does occur, this can usually be managed by reduction or discontinuation of the relevant AED. In clinical practice, if a patient presents with depression, the possibility that this has been precipitated by anti-epileptic medication should be considered and the treatment should be reviewed. In particular, polytherapy should be avoided in such patients. Consideration may be given to prescribing an AED that is more likely to be associated with an improvement in depression, such as carbamazepine or lamotrigine.

There is increasing evidence that good clinical management can decrease the risk of psychiatric adverse effects of AEDs: knowing which drugs are most likely to be implicated, starting with low doses and escalating slowly, and identifying those patients who will require close monitoring because of clinical risk factors, including a history of psychiatric disorders, febrile seizures or hippocampal sclerosis, should decrease the occurrence of such adverse effects in the future (table 6).

### Acknowledgments

The authors would like to thank Professor Frank M.C. Besag for assistance with the preparation of the manuscript. The authors received no funding for the present paper. The authors have received travel grants or consultancy fees, from various pharmaceutical companies including Novartis, Pfizer, UCB, Schwarz Pharma, Janssen-Cilag, Sanofi-Aventis, and GSK – involved in the manufacture of anti-epileptic drugs.

### References


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**Table 5. Variables involved in AEDs-related psychopathology.**

<table>
<thead>
<tr>
<th></th>
<th>VGB (Thomas et al. 1996)</th>
<th>TPM (Mula et al. 2003a)</th>
<th>LEV (Mula et al. 2003c)</th>
<th>TPM-LEV (Mula et al. 2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of febrile convulsions</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>History of status epilepticus</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>?</td>
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<tr>
<td>Previous psychiatric history</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Family history of epilepsy</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Family psychiatric history</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>+</td>
</tr>
<tr>
<td>Seizure-freedom</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>+</td>
</tr>
</tbody>
</table>

**Table 6. Treatment considerations in epilepsy with psychiatric comorbidity.**

<table>
<thead>
<tr>
<th>Co-morbidity</th>
<th>Avoid</th>
<th>Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>Barbiturates, VGB, TGB, TPM</td>
<td>LTG</td>
</tr>
<tr>
<td>Anxiety</td>
<td>LTG, FBM, LEV</td>
<td>BZD, GBP, PGB</td>
</tr>
<tr>
<td>Psychosis</td>
<td>VGB, TPM, ESM</td>
<td>LEV</td>
</tr>
</tbody>
</table>

BZD: benzodiazepines; ESM: ethosuximide; FBM: felbamate; GBP: gabapentin; LEV: levetiracetam; LTG: lamotrigine; TGB: tiagabine; TPM: topiramate; VGB: vigabatrin.


