



Noncompliance of patients with driving restrictions due to uncontrolled epilepsy

Laurent M. Willems^{a,*}, Philipp S. Reif^a, Susanne Knake^b, Hajo M. Hamer^c, Constantin Willems^d, Günter Krämer^e, Felix Rosenow^{a,b}, Adam Strzelczyk^{a,b}

^a Epilepsy Center Frankfurt Rhine-Main and Department of Neurology, Goethe-University, Frankfurt am Main, Germany

^b Epilepsy Center Hessen and Department of Neurology, Philipps-University, Marburg, Germany

^c Epilepsy Center Erlangen and Department of Neurology, University Hospital Erlangen, Erlangen, Germany

^d Faculty of Law, Philipps-University, Marburg, Germany

^e Neurozentrum Bellevue, Zürich, Switzerland

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ABSTRACT

Epilepsies are a common and chronic neurological disorder characterized by sustained risk of recurrent seizures. Because of paroxysmal and often unpredictable occurrence of seizures, patients with uncontrolled epilepsy are subject to disease-specific restrictions in daily life, such as their career choice or specific work limitations. According to German law and many other European and international guidelines, driving is strictly prohibited in patients with uncontrolled epilepsy so as to increase active and passive safety in public road traffic. Nevertheless, a significant percentage of patients probably do not comply with these legal restrictions and drive on a regular basis. For this study, we analyzed a representative German cohort with 302 patients (mean age: 45.0 years \pm 16.4; 48% male) with established epilepsy to identify the number of patients driving without permission. Overall, 58.6% (n = 177) of patients had a driving license, 71.1% (n = 69/97) of patients were in seizure remission, and 52.7% (n = 108/205) of patients had uncontrolled epilepsy. Among patients in seizure remission, 54.6% (n = 53/97) reported regular driving while, among patients with uncontrolled epilepsy, 15.1% (n = 31/205) reported driving on a regular basis. No patient in the cohort stated driving without a valid license. Permanent employment, freelance work, the absence of a relevant disability, and living alone were identified as significant risk factors, which underlines the already existing evidence for the importance of a possible restricted access to the labor market as motive for disregarding legal driving restrictions.

In our opinion, specialized and generally available social counseling with a special focus on vocational and career guidance is urgently needed to improve compliance with epilepsy-caused driving restrictions and the underlying reasons for violating these rules. In addition, more effort has to be spent on improving diagnostics and treatment of epilepsy to reduce the number of patients with uncontrolled seizures. Comprehensive introduction of self-driving vehicles may also help to improve mobility of patients with refractory epilepsy.

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1. Introduction

One of the fundamental conditions in today's labor market is flexibility and mobility. The general shortage of attractive employments and diversification of the labor market force workers to commute to work. Moreover, many project-based working situations rely on a permanent mobility over larger distances. The loss of driving permission is often synonymous with losing a job. However, permission to drive is often

restricted or revoked in patients with diseases influencing their awareness, response speed, or certain mental and physical disabilities.

Because of the paroxysmal and often unpredictable occurrence of seizures, patients with uncontrolled epilepsy, i.e., at least one seizure during the last 12 months following the classification of the International League Against Epilepsy (ILAE) [1], have limited or eliminated driving aptitude. The main reason for driving restriction in these patients is the assumption that they have a higher risk for active car accidents, which is controversially discussed because of contradictory findings in the past [2–7]. Restrictions on driving are usually regulated by country-specific laws or regulations. In Germany, epilepsy-specific limitations are defined by the Federal Highway Research Institute (Bundesanstalt für Straßenwesen) and strictly distinguishes driving of cars (<3.5 tons total weight) and trucks or lorries (>3.5 tons total

* Corresponding author at: Epilepsy Center Frankfurt Rhine-Main, Department of Neurology, J.W. Goethe-University Frankfurt, Schleusenweg 2-16, 60528 Frankfurt am Main, Germany.

E-mail address: Laurent.willems@kgu.de (L.M. Willems).

Table 1
Legal restrictions of driving in patients with epilepsy according to German law.

Clinical aspects	Restriction of driving fitness in months	
	Cars and small vehicles (total weight < 3.5 tons)	Lorries and trucks (total weight > 3.5 tons)
First provoked seizure		
With avoidable cause	3	6
Without avoidable cause	6	24
Established epilepsy		
Seizure-free under AED	12	Permanent
Sporadic seizure with avoidable cause ^a	3	Permanent
Sporadic seizure without avoidable cause ^a	6	Permanent
Seizure-free without AED	12	60

Modified after Gräcmann et al. (2009) Begutachtungs-Leitlinien zur Kraftfahrereignung [8,9].

^a Applicable to patients in long-term remission.

weight). Whereas professional drivers with epilepsy are mostly not allowed to drive trucks, the private use of cars can be permitted, but specific restrictions apply (see Table 1). Most patients with epilepsy with a reliable and continuous seizure freedom of over 12 months are allowed to drive for private use, if holding a valid driving license [8].

The objective of this study was to determine the number of patients with uncontrolled epilepsy disregarding legal restrictions on driving and to identify possible risk factors. Moreover, risk factors and motivations for disregarding legal driving restrictions were analyzed and discussed.

2. Methods

This survey was part of a large study [10,11] on quality of life, burden of disease, and health economics in people with epilepsy performed in 2008 in Hessen, Germany and was approved by the local ethics committee. All adult patients with established epilepsy were eligible after receiving written informed consent. Epilepsy and refractory course were defined according to ILAE definitions [1,12]. Patients were enrolled by general practitioners and neurologists and at the epilepsy center. Data acquisition was performed using a patient questionnaire with over 250 items regarding sociodemographic and socioeconomic aspects as well as neuropsychological tests and different scores. In addition, disease-specific information regarding epilepsy syndrome, disease duration, seizure types and antiepileptic drugs (AEDs) was supplied by the treating physician. Information on uncontrolled epilepsy and driving behavior were independently assessed to prevent possible bias because of social desirability. To achieve a high accuracy of data regarding the noncompliance of patients with uncontrolled epilepsy and a restricted aptitude to drive, all patients with newly diagnosed epilepsy and only sleep-associated seizures were excluded. According to German law, all residual patients in the study with uncontrolled epilepsy must not drive a car, bus, or truck on public roads. During the study period, the authors did not become aware of any motor vehicle accidents among the study population.

Under German law, it is an offense in itself to drive without a valid driving permission (section 21 of the German Road Traffic Act [StVG – Straßenverkehrsgesetz] in connection with the German bylaw on driving permission [FEV – Fahrerlaubnisverordnung]). Concerning epilepsy and road traffic, the offense resulting in the highest threat of punishment is stated in section 315c (1) of the German Criminal Code (StGB – Strafgesetzbuch). This section makes it a crime to drive a vehicle in road traffic if, because of mental or physical defects, the driver is not in a condition to drive the vehicle safely and, thereby, endangers the life or limb of another person or property of significant value belonging to another. It is established that epilepsy is regarded as a “mental defect” in the context of this section, at least in cases in which there is an imminent threat of acute epileptic seizures [13,14]. According to German criminal law, the imposition of punishment and measures shall be excluded on expiry of a certain limitation period (for limitation on prosecution, see section 78 (1) of the German Criminal Code). The length of the limitation period depends on the maximum punishment provided

for the crime at hand. This analysis has been carried out after limitation periods had expired and at a time in which criminal prosecution of the involved persons was excluded.

Statistical analyses were performed using chi-square and IBM SPSS Statistics 22 (IBM Corporation, Armonk, NY, USA) or BiAS for Windows version 11.04 (Epsilon Verlag, Frankfurt, Germany).

3. Results

The cohort comprised 302 patients with uncontrolled epilepsy ($n = 205$; 67.9%) and patients in seizure remission for more than one year ($n = 97$; 29.5%). Gender distribution was balanced (52.0% female, 48.0% male) while mean age was 45.0 years \pm 16.4 years (range: 18–87 years). Most patients were on anticonvulsant therapy with one ($n = 129$; 42.7%) or two or more AEDs ($n = 151$; 50%). Only 7.3% ($n = 22$) reported no AED intake. The majority of the cohort had a focal epilepsy (70.2%, $n = 212$), and 21.5% ($n = 65$) were classified to have idiopathic generalized epilepsy (Table 2).

Overall, 58.6% ($n = 177$) of patients had a driving license, 71.1% ($n = 69/97$) within the epilepsy in remission group and 52.7% ($n = 108/205$) in the cohort with uncontrolled epilepsy. From the patients in seizure remission, 54.6% ($n = 53/97$) reported regular driving while 16.5% ($n = 16/97$) reported not driving despite seizure remission and driving permission. No patient in the cohort stated driving without a valid license. Among patients with uncontrolled epilepsy, 15.1% ($n = 31/205$) reported driving on a regular basis without permission. Most patients within this

Table 2
Clinical characteristics.

	All patients ($n = 302$)	Epilepsy in remission ($n = 97$)	Uncontrolled epilepsy ($n = 205$)
Age ^a	45.0 \pm 16.4 ^a range: 18–87	48.6 \pm 16.6 ^a range: 19–87	42.9 \pm 15.8 ^a range: 18–85
Sex			
Female	52.0 (157)	49.5 (48)	53.2 (109)
Male	48.0 (145)	51.5 (49)	56.7 (96)
AED regimen			
Mean ^a	1.5 \pm 0.8 ^a range: 0–4	1.2 \pm 0.6 ^a range: 0–3	1.7 \pm 0.8 ^a range: 0–5
No AED	7.3 (22)	9.0 (8)	4.4 (9)
1 AED	42.7 (129)	65.2 (58)	33.2 (68)
≥ 2 AED	50 (151)	25.8 (23)	62.4 (128)
Epilepsy syndrome			
Focal	70.2 (212)	60.8 (59)	74.6 (153)
Generalized	21.5 (65)	30.9 (30)	17.1 (35)
Unknown	8.3 (25)	8.7 (8)	8.3 (17)
Uncontrolled epilepsy			
Yes	67.9 (205)	0.0 (0)	100.0 (205)
No	29.5 (89)	100.0 (97)	0.0 (0)

AED = antiepileptic drug.

^a Mean \pm SD.

Table 3
Noncompliance with driving restrictions in patients with uncontrolled epilepsy.

	All patients (n = 302)	Uncontrolled epilepsy (n = 205)	Driving (n = 31)	Not driving (n = 174)
Age ^a	45.0 ± 16.4 ^a range: 18–87	42.9 ± 15.8 ^a range: 18–85	44.1 ± 11.9 ^a range: 22–71	42.6 ± 16.4 ^a range: 18–85
AED regimen ^a	1.5 ± 0.8 ^a range: 0–4	1.7 ± 0.8 ^a range: 0–4	1.3 ± 0.7 ^a range: 0–2	1.8 ± 0.8 ^a range: 0–4
Driving license				
Yes	58.6 (177)	52.7 (108)	96.8 (30)	44.6 (78)
No	40.1 (121)	45.8 (94)	0.0 (0)	53.7 (94)
N.A.	1.3 (4)	1.5 (3)	3.2 (1)	0.1 (2)
Driving				
Yes	27.8 (84)	15.1 (31)	100.0 (31)	0.0 (0)
No	72.2 (218)	84.9 (174)	0.0 (0)	100.0 (174)
Injuries and accidents				
Total number	21.2 (64)	27.3 (56)	19.3 (6)	28.7 (50)
Mean	0.2 ± 0.5 ^a range: 0–2	0.3 ± 0.6 ^a range: 0–2	0.3 ± 0.6 ^a range: 0–2	0.3 ± 0.5 ^a range: 0–2
Seizure frequency				
≥ 1/day	8.9 (27)	13.1 (27)	12.9 (4)	13.1 (23)
≥ 1/week	20.5 (62)	30.2 (62)	16.1 (5)	32.6 (57)
≥ 1/month	17.5 (53)	25.9 (53)	16.1 (5)	27.4 (48)
≥ 1/3 months	7.0 (21)	10.2 (21)	16.1 (5)	9.1 (16)
≥ 1/6 months	6.0 (18)	8.8 (18)	16.1 (5)	7.4 (13)
≥ 1/year	7.6 (23)	11.2 (23)	22.6 (7)	9.1 (16)

AED = antiepileptic drug.

^a Mean ± SD.

group reported frequent seizures, i.e., 13.1% at least one seizure per day, 30.2% at least one seizure per week, and 25.9% more than one seizure per month (Table 3). The univariate risk factor analysis revealed a significant difference between employed and unemployed patients, with those in employment driving more frequently ($p < 0.001$). Moreover, freelance-working patients drove significantly more often compared with salaried employees ($p = 0.049$). Other significant factors correlating with noncompliance of driving restrictions in patients with uncontrolled epilepsy were living alone ($p < 0.001$) and the absence of physical disabilities or handicaps ($p = 0.028$). All other tested

Table 4
Potential risk factors for patients with uncontrolled epilepsy ignoring their driving restrictions.

Parameter	Driving (n = 31)	Nondriving (n = 174)	Sum	p-Value
Sex				
Female	12	97	109	0.080
Male	19	77	96	
Age				
<45	18	111	129	0.543
>45	13	63	76	
Seizure frequency				
< 1/month	3	8	11	0.248
> 1/month	28	166	194	
Education				
< 12 years	9	38	47	0.380
> 12 years	22	136	158	
Disability				
Yes	15	113	148	0.028
No	16	61	77	
Employment				
Yes	22	50	72	<0.001
No	9	142	151	
Freelance work				
Yes	2	2	4	0.049
No	29	172	201	
Living alone				
Yes	22	47	69	<0.001
No	9	127	136	

AED = antiepileptic drug.

items showed no significant difference between both subgroups in age, gender, seizure frequency, or education (Table 4).

Epilepsy-related injuries and accidents were reported in 64 (32.2%) of the 302 enrolled patients. Among patients with uncontrolled epilepsy, injuries and accidents were less frequent among patients that reported driving (19.3%; $n = 6/31$) compared with nondrivers (28.7%; $n = 50/174$; $p = 0.28$). Overall, one accident in public traffic was reported but not further specified. Within the nondriving patients with uncontrolled epilepsy and all other patients with epilepsy in remission, no further traffic accidents were reported (Table 3).

4. Discussion

Restrictions of driving permission in patients with uncontrolled epilepsy have to be communicated to all patients, and this may be associated with difficulties and discomfort in the circumstance of newly diagnosed epilepsy or ongoing seizures. Neurologists and neuropsychiatrists in three German-speaking countries report counseling nearly all their patients on driving restrictions [13].

On the one hand, restrictions are a major burden for the patients and their mobility and access to the labor market [14], but on the other hand, they might help in minimizing epilepsy-related injuries and accidents. However, driving restrictions are a contentious topic that has to balance between safety and practicality [3]. Violation of these legal restrictions can have devastating effects and may have related legal consequences [15]. Data from 1996 revealed no evidence of an increased overall risk of accidents in drivers with epilepsy vs. healthy drivers [7] and demonstrated that the number of seizures associated with fatal car accidents was inferior to other common causes (e.g., alcohol abuse) [2]. In contrast, a Danish study from 2001 showed a seven times increase in car accident rates in patients with epilepsy compared with healthy controls [4]. Two recently published studies in patients with uncontrolled epilepsy revealed that 34–78% of the study population ignored their individual driving restrictions and that up to 6% reported motor vehicle accidents associated with seizures during that time [16,17].

In our cohort, 15.1% of patients with uncontrolled epilepsy reported driving a car on a regular basis, thereby violating their driving restrictions. Our findings are substantially lower but comparable with other studies, with driving rates of up to 78% in patients with uncontrolled epilepsy [16–18], which may be caused by the study setting or local peculiarities. Possible limitations of this study may also result from the limited number of patients and the usage of a patient-based questionnaire. False negative statements could lead to under- and false positive declarations (e.g., patients who cannot admit to not driving) and may result in an overestimation of the number of people disregarding their driving restriction. In particular, the fear of legal consequences may have also led to a systematical underreporting so that a higher frequency of driving in patients with active epilepsy has to be assumed, which would be in line with other studies using anonymous questionnaires reporting considerably higher driving rates [17]. Moreover, the questionnaire was not primarily targeting driving behavior and its possible consequences. However, this may reduce the bias due to social desirability.

Generally, having an employment or being self-employed was a significant risk factor for ignoring driving restrictions in patients with active epilepsy in our cohort. In line with our findings, an occupational purpose or the maintenance of an employment was the most frequent justifying reasons for disobeying individual driving restrictions in an earlier study [6] and a multivariable analysis revealed an increased likelihood of driving in patients that were in employment [18]. These findings support the importance of employability aspects in patients with restricted driving aptitude. Here, frank handling of the diagnosis and a special protection against dismissal may help to reduce the number of illegal drivers although this may be difficult to implement in modern job markets. Moreover, the absence of relevant physical disabilities

and living alone were significantly increased risk factors for ignoring driving restrictions, which is in line with published data showing a negative correlation of violating driving restrictions and patients with self-described disabilities [18]. All other tested parameters did not reach significance between both groups in our cohort (i.e., sex, age, education, seizure frequency; see Table 4). These findings are in contrast to those of another study that revealed masculine gender, middle age, low education, and low income as risk factors for noncompliance with driving restrictions in people with epilepsy [6]. Others reported a positive correlation with young age and male gender [18].

Uncontrolled epilepsy has been identified as a major risk factor for accidents and injuries [19,20], which is well in line with the results of our cohort, showing an increased rate of injuries in the cohort with active epilepsy, with 56 of 64 reported accidents (87.5%). However, all but one reported accidents were not related to public road traffic. One male patient reported an epilepsy-associated accident in road traffic during the observation period. As the questionnaire was not focused on epilepsy-related injuries, further details on the cause of the accident are not available.

We were able to show that approximately 15% of patients with uncontrolled epilepsy drive on a regular basis and, thereby, violate driving restrictions. If this behavior leads to an increased number of traffic accidents, it can be controversially discussed and this was not the aim of this study. The significantly increased number of patients with an employment or working self-employed as well as previous findings showing that an occupational purpose or the maintenance of an employment were the most frequent justifying reasons for disobeying individual driving restrictions, underlining the importance of economic and social compulsions in patients with uncontrolled epilepsy [6,21]. Driving restriction has a major impact in social counseling and educating patients [22], and future efforts should focus on improved strategies to overcome these restrictions. A sole reporting of laws, legal restrictions, and their consequences to the patients is not effective to completely prevent driving in other neurological diseases [23]. Therefore, special focus should be set on vocational and career guidance to facilitate patients to staying employed but using alternative work strategies (e.g., home office). In addition, comprehensive introduction of self-driving vehicles may also help to improve mobility of patients with refractory epilepsy. Otherwise, the medical, social, and economic consequences of neglecting or abandoning the needs of these predominantly young and intrinsically motivated patients may have disastrous consequences.

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Conflicts of interest

L.M. Willems, P.S. Reif, and C. Willems report no conflicts of interest.

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We confirm that we have read the journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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