Seizure 1995; **4**: 303–306

Natural atmospherics and occurrence of seizures in six adolescents with epilepsy: a cross correlation study

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As already seen in a former study of 315 epileptic seizures in adults, subsequent investigation of 3333 epileptic seizures in six adolescents revealed a significant increase of the seizure frequency during days with a higher mean frequency of 28 kHz atmospherics, and a decrease during days with a (Baumer apparatus) distinctly higher amount of 10 kHz when compared with the daily mean frequency within the whole period. However, one patient showed an opposite behaviour regarding the correlations of 28 and 10 kHz atmospherics and the mean numbers of seizures.

Key words: epileptic seizures; atmospherics (atB); adolescents; atmospheric correlations.

INTRODUCTION

We know from very early reports that a number of diseases will deteriorate, if certain weather conditions prevail. Since about 1850, many investigators have attempted to discover which parameters were responsible for these correlations. Especially the so-called classical weather parameters—such as mean temperature, air pressure or humidity—had been investigated. However, most of the correlations found were neither high nor common enough to explain those connections. On the basis of several observations proposed by Baumer and Eichmeier[1–3], naturally occurring alternating electromagnetic fields, so-called 'atmospherics' (spherics), could also be important in these relationships.

Atmospherics are naturally occurring, very short and very weak damped electromagnetic impulses in the range of 4–50 kHz. The origin of atmospherics is controversial. One theory attributes them only to the activity of world-wide lightning. Another interpretation, which corresponds to the definition of atmospherics put forth by the World Meteorological Organization[4], favours the concept that in addition to lightning as the main source of atmospherics, the counter movements of air masses 400–500 km around the observation point can also contribute to the generation of atmospherics[5].

Atmospherics were suspected to have biological effects from as early as 1930. But only after 1980, when Baumer constructed a very sophisticated measuring device[1], was it possible to analyse this problem in detail (US patent Nos. 4631951 and 46849591)[6]. Baumer and Eichmeier[2] found that according to this apparatus, atmospherics are not equally distributed over the range of frequencies, but instead 6, 8, 10, 12 and 28 kHz frequencies prevail.

In 1992, König, Kulzer, Gerl and Betz published a report on another system for measuring atmospherics[7], but their results did not completely agree with those obtained with the Baumer apparatus. The reason for these differences is not yet clear. However, our findings for several biological/pathological parameters demonstrated some high correlations with different spectra of atmospherics measured by the Baumer apparatus, so that there can be no doubt that the Baumer data must have biological significance, irrespective of their physical explanation. Because the physics of the measured impulses have not yet been clarified in detail, for the

1059–1311/95/040303 + 04 $12.00/0

purpose of clarity, we named the data measured by the Baumer apparatus 'according to Baumer (atB)'[8].

A significant correlation between certain spectra of atmospherics (despite their very weak intensity) and a biochemical parameter was observed, namely the permeability of gelatine films to iron (III) chloride[2]. Furthermore, Sönning, Baumer and Eichmeier found that certain dynamic weather processes also show highly significant correlations with certain spectra of atmospherics[9].

Gelatine is derived from connective tissue. Therefore, it seemed possible that such correlations could also exist between other biological or pathological parameters, and in fact, Hoffmann, Vogl, Baumer, Kempski and Ruhenstroth-Bauer[10] found in 1991 highly significant correlations with low probabilities of error between nine biological/pathological entities and certain spectra of atmospherics (atB). Amongst others, epileptic seizures were found to display such correlations.

The first study of epileptic patients was performed from January to July 1981 and included 315 seizures in six epileptic patients[11]. If the mean daily difference of the sums s(28 kHz) − s(10 kHz) of atmospherics was positive, there was a positive correlation of 0.30 to the number of seizures. If, however, the difference was negative, the correlation was negative at −0.20. To confirm this result, Christine Moritz recently repeated this study with 3333 seizures in six adolescents[12]. In this paper, it is shown that her results were practically identical with those of the former investigation. Moreover, we found some new evidence which may be important in the elucidation of the mechanisms of these relationships.

PATIENTS AND METHODS

Electrical measurement techniques

The Baumer apparatus has been described in detail in the above mentioned USA patents. In short, atmospherics were measured by means of two seven-element ferrite antennae with pre-amplifiers installed 17 m above ground level. The signals received were conducted to measuring and recording devices by means of coaxial cables. Impulses were detectable over an area of radius approximately 400–500 km from the receiving station. In principle, therefore, we are concerned with ground wave propagation. Ionospheric reflections play only a subordinate role.

Nevertheless, the input sensitivity of the installation was automatically tuned to and calibrated by a high-stability subsidiary transmitter at a distance of 350 km in order to minimize transhorizontal propagation. The self-resonance of the 10 KHz antenna was enhanced electronically to produce a wide-band magnetic antenna. The incoming impulses were sorted into appropriate channels on the basis of their measured frequencies. By means of digital filtering, the bandwidths were closely defined as 10 kHz ± 700 Hz and 28 kHz ± 1.5 kHz, appropriate for the energy distribution of the frequency spectrum of atmospherics. Each signal was further analysed to see if it had a sine-wave configuration, non-sine-wave signals were disregarded. Similarly, electromagnetic impulses (EMP) were not recorded. Impulses or groups of impulses selected in this manner were counted per unit of time and transferred to the printer in three steps. The first step corresponds to a very low and the second to an average activity. The third step is defined as that step by which the frequency sequence of the impulse is 3.0 Hz or greater. The daily mean value was calculated as the average of the hourly means of these activity levels.

PATIENTS

The investigations consisted of analysing data from six patients with very frequent seizures. Their personal data are shown in Table 1. Their seizures were registered between January 1988 and April 1989. Details of the seizures were registered using a questionaire which was completed by nurses or relatives of the patients. The

Table 1: Personal data of the six patients. The antiepileptic rediation was not altered during the observation period

Patient	Age (years)	Aetiology of seizures	Type of seizures	Mean frequency of seizures/ month
A	16	Perinatal cerebral injury	Myoclonic astatic	45
B	27	Perinatal cerebral injury	Tonic	43
C	16	Perinatal cerebral injury	Generalized tonic-clonic absences	26 8
D	12	Sturge-Weber syndrome	Generalized tonic-clonic	63
E	21	Postencephalitic cerebral damage	Tonic	11
F	19	Perinatal cerebral injury	Tonic	7

total number of seizures was 3333. Table 2 shows the distribution among the patients. More detailed observations can be found elsewhere[6,12].

These data were arranged chronologically, i.e. they were registered in a 'calendar' and then compared with the 'calendar' of the atmospherics (atB). Finally, we calculated the correlations (r) and the probability (P) between these calendric data.

RESULTS

Table 3 shows the data correlations of all six patients (A–F). If the 10 kHz (atB) decreased, we found a highly significant increase in the frequency of seizures ($r = -0.68$; $P = 0.007$). Especially impressive are the correlations of patient D ($r = -0.80$; $P = -0.002$). An increase in the 28 kHz atmospherics (atB) was related, however, to an increase in the frequency of the seizures, but this correlation was not statistically significant. Very important is the observation that again one patient, namely patient A, showed inverse correlations for all the measurements (Table 3).

We also calculated the correlation between the number of seizures and the differences between the two frequencies (s(10 kHz) − s(28 kHz)) (atB). The correlation was almost identical with the values of 10 kHz ($r = -0.67$; $P = 0.007$). One patient (A) again showed an inverse correlation. The correlations of the 8 kHz (atB) were similar to those of 10 kHz impulses.

A further observation may help to elucidate the mechanism of these relationships: we found only high correlations between the 10 kHz frequency and the number of seizures, when at the same time a weak activity (up to 10%) of the 28 kHz impulses (atB) was observed. The 10 kHz impulses (atB) alone had only a very low correlation. The same is true for the 28 kHz impulses (atB): only the addition of a small portion of the 10 kHz impulses (atB) results in a high correlation.

Table 3: The correlations (r) and probabilities (P) between the different impulse spectra and the frequency of seizures

Frequency of atmospherics	Sum of seizures	r	P
s(10 kHz) − s(28 kHz)	Patients A to F	−0.67	0.007
	Patient A	+0.43	0.09
	Patient D	−0.77	0.004
28 kHz	Patients A to F	+0.33	—
	Patient A	−0.42	0.10
	Patient D	+0.32	—
10 kHz	Patients A to F	−0.68	0.007
	Patient A	+0.39	0.10
	Patient D	−0.80	0.002
8 kHz	Patients A to F	−0.43	0.09
	Patient A	+0.73	0.005
	Patient D	−0.65	0.004

DISCUSSION

The evaluation of 3333 seizures in six epileptic adolescents confirm the results of our former study of 315 seizures: on days when 10 kHz atmospherics (atB) prevail, the mean number of seizures is reduced in the majority of patients. The opposite occurs if 28 kHz impulses (atB) prevail. The changes with the 10 kHz atmospherics are highly significant with low probabilities of error. Furthermore, we found one single epileptic patient (A) with opposite correlations concerning the relationship to the 10 and 28 kHz impulses (atB).

Besides confirming our former results, we made a theoretically and clinically important observation: on days with only 10 or 28 kHz impulses (atB), the differences from the mean number of seizures were small. Only if a small number (up to 10%) of opposite frequencies was added, the high correlation mentioned here was observed. The reason for this observation is

Table 2: Monthly distribution of seizures in the six patients during 1988/89

	1988												1989			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
Patient																
A	50	47	51	37	52	39	68	80	39	60	40	26	40	38	54	36
B	90	28	27	46	42	39	21	37	83	33	44	39	57	41	41	52
C	38	39	28	15	15	10	34	56	41	24	34	52	41	37	42	41
D	33	43	52	54	43	47	52	34	67	47	48	81	81	111	97	106
E	7	8	12	8	5	12	11	11	15	5	19	14	7	12	12	13
F	1	6	6	12	6	13	9	5	8	13	13	9	5	9	10	14
Total	219	171	176	172	163	160	195	223	253	182	198	221	231	248	256	262

unclear. But this fact is in agreement with a former observation with C6-Glioma cells *in vitro*[8]: the 10 or 28 kHz atmospherics (atB) alone were possibly only indicators of biological/ pathological active signals.

In recent years several observations have been reported on the influence of alternating magnetic fields on epileptic seizures. One was the observation that weak alternating magnetic fields of very low frequency can influence epileptic seizures[13,14].

Twenty-eight and 10 kHz atmospherics (atB) are closely related to meteorological changes as shown by analysis of the daily atmospheric pattern between May 1978 and April 1979[15]. The authors found that the 28 kHz (atB) atmospherics' activity increased at days with vertical air movement and high reaching turbulences in particular. The 10 kHz (atB) atmospherics, however, were associated with increased horizontal movement of air masses. From this, one may assume that the frequency of epileptic seizures increases mainly on days with little horizontal and massive vertical movements, a situation typical of an approaching cold front.

In the meantime, we succeeded in constructing an apparatus which artificially simulates certain naturally occurring atmospherics spectra[16]. This apparatus can influence the proliferative activity of C6-Glioma cells *in vitro* in a similar manner as is shown by the correlation with naturally occurring atmospherics. We are now at the point of investigating whether artificial atmospherics simulating natural ones can also influence epileptic seizures.

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