Article

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Emergency EEG

Study of survival

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ABSTRACT

Objective: To determine the survival rate according to the main findings of emergency electroencephalography (EEGs) of patients treated in a tertiary hospital. **Method:** In this prospective study, the findings of consecutive emergency EEGs performed on inpatients in Hospital de Base in São José do Rio Preto, Brazil were correlated with survival utilizing Kaplan-Meyer survival curves. **Results:** A total of 681 patients with an average age of 42 years old (1 day to 96 years) were evaluated, of which 406 were male. The main reasons for EEGs were epileptic seizures (221 cases), hepatic encephalopathy [116 cases of which 85 (73.3%) were men, p-value=0.001], status epilepticus (104 cases) and impaired consciousness (78 cases). The underlying disease was confirmed in 578 (84.3%) cases with 119 (17.5%) having liver disease [91 (76.0%) were men, p-value=0.001], 105 (15.4%) suffering strokes, 67 (9.9%) having metabolic disorders, 51 (7.5%) central nervous system infections and 49 (7.2%) epilepsy. In the three months following EEG, a survival rate of 75% was found in patients with normal, discreet slow activity or intermittent rhythmic delta activity EEGs, of 50% for those with continuous delta activity and generalized epileptiform discharges, and of 25% for those with burst-suppression, diffuse depression, and in alpha/theta-pattern coma. Death was pronounced immediately in patients with isoelectric EEGs. **Conclusion:** The main findings of EEGs, differentiated different survival rates and are thus a good prognostic tool for patients examined in emergencies.

Key words: EEG, emergency, prognosis, probability of survival.

EEG de urgência: taxa de sobrevivência

RESUMO

Objetivo: Determinar a taxa de sobrevivência (TS), segundo os principais achados de eletrencefalograma de urgência (E-EEG), dos pacientes atendidos nas emergências de hospital de alta complexidade. **Método:** Estudo prospectivo, por ordem de chegada, da correlação entre os achados de E-EEG, feitos nos pacientes à beira do leito, com TS, utilizando-se as curvas de sobrevidas de Kaplan Meyer no Hospital de Base de São José do Rio Preto, São Paulo/Brasil. **Resultados:** Foram estudados 681 pacientes, dos quais 406 (59,6%) masculinos, com idade média de 42 anos (1 dia a 96 anos). As principais motivações para o E-EEG foram crises epilépticas (221 casos), encefalopatia hepática [(116 casos, dos quais 85 masculinos (73,3%), p= 0,001]; estado de mal epiléptico 104 e rebaixamento de consciência 78. O diagnóstico da doença de base foi confirmado em 578 (84,3%), sendo 119 (17,5%) hepatopatia, dos quais 91 (76,%) masculinos, p= 0,001; 105 (15,4%) acidente vascular encefálico; 67 (9,9%) distúrbio metabólico; 51 (7,5%) infecção do sistema nervoso central e 49 (7,2%) epilepsia. TS de 75% nos três primeiros meses foi encontrada nos pacientes com E-EEG com alentecimento discreto ou com atividade delta rítmica intermitente. TS por volta de 50% nos três meses foi encontrado nos pacientes com E-EEG com delta contínuo, crítico e com descargas periódicas. A TS foi menor que 25% nos dois primeiros meses após E-EEG, nos pacientes com E-EEG com surto/supressão, com depressão difusa e com comas alfa/teta e 0% nos E-EEG iselétricos. **Conclusão:** O E-EEG, com seus principais achados, foi capaz de diferenciar as diversas taxas de sobrevivências na amostra estudada, constituindo-se, portanto, bom instrumento de prognóstico para pacientes atendidos nas unidades de emergência hospitalar.

Palavras-chave: EEG, emergência, probabilidade de sobrevida.

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Emergency departments and intensive care units (ICU) are becoming increasingly more important in hospitals. Within the enormous range of tools available in these sectors, emergency electroencephalography (EEG), due to its low cost, the time required to carry out the examination, the lack of risk and personnel requirements, contributes greatly to the treatment of patients with acute diseases, in particular those with changes in consciousness[1-3]. The different patterns of EEG obtained in emergency patients, although nonspecific, can often be correlated with the etiology of diseases of the central nervous system such as trauma[4], vascular injury and anoxic-ischemic injury due to cardiorespiratory arrest[5]. In hepatic encephalopathy[6,7], Creutzfeldt-Jakob disease[8], non-convulsive status epilepticus[9-15] and herpes simplex encephalitis[16], EEG is decisive for diagnosis and thus guides therapy and gives an indication of the prognosis.

EEG also contributes by characterizing the state of consciousness in exogen intoxication and metabolic encephalopathy[17,18]. Hence, EEG has gained importance in the identification of cases with persistently reduced consciousness but with normal imaging examinations[4,18].

This study aimed at correlating survival to emergency EEG findings in patients examined in a tertiary hospital.

METHOD

This is a prospective study of emergency EEGs obtained from patients submitted to urgent examinations in the Emergency Department, on the ward or in intensive care units (ICUs) of Hospital de Base in São José do Rio Preto. Hospital de Base is a tertiary hospital and regional reference center with 716 beds, 155 of which are in ICUs. The Emergency Department attends an average of 9,700 patients per month.

The emergency EEGs were performed in the laboratory of neurophysiology or at the bedside. Electrodes were placed according to the 10/20 international system utilizing two Berg analogue apparatuses (time constant: 0.3; filter: 70 Hz; notch filter: 60 Hz; paper speed: 3 cm/second) with eight channels and two Nihon digital apparatuses (12-bit) with 22 channels. Only the first emergency EEG examination of each patient studied between 1/7/06 and 1/8/07 was included in this work, although some patients were submitted to as many as 10 examinations. The results were interpreted by two experienced neurophysiologists (MAB, NSAM) assisted by two trainees (HJB, FRB), with the final decision being by consensus. Patients with diagnoses from previous hospitalizations, those with technically low quality examinations and patients for whom consent to participate was refused by the next of kin were excluded from the study.

For study purposes, only the most significant alteration, whether related to the baseline rhythm or paroxistic disorders, was considered in each EEG; some examinations had more than one evident alteration. Thus, only one emergency EEG result was analyzed for each patient. The following findings were standardized according to the modified criteria of Husain[3]: 1) intermittent rhythmic delta activity (IRDA); 2) critical activity epileptiform according to Treiman et al.[19] with modifications by Garzon et al.[20]; 3) normal; 4) burst-suppression; 5) continuous high-voltage delta activity according to Amodio et al.[7]; 6) low-voltage, slow, nonreactive EEG of less than 10 mV; 7) diffuse periodic epileptiform disorder (PED) and lateralized (PLED); 8) coma with specific rhythms (alpha, theta and spindle); 9) electrocerebral inactivity (according to the minimum technical requirements proposed by the American Clinical Neurophysiology Society and 10) intercritical epileptiform disorder. The data were obtained and stored in an Excel spreadsheet.

Diagnosis of the underlying disease was made by investigating the clinical history, even if precarious, complementary biochemical examinations, imaging examinations such as computed tomography and magnetic resonance, as well as the diagnosis confirmation service, that is, autopsy.

Epilepsy was diagnosed only when epileptic seizures occurred, without being caused by any acute disorder, on more than two occasions with an interval of more than 24 hours. Generalized convulsive status epilepticus (GCSE) was defined according to the Commission of Classification and Terminology of the International League against Epilepsy[21], with modifications by Lowenstein et al.[22] and Brenner[14].

The Pearson chi-square or Fisher exact tests were utilized in the statistical analysis of the gender, age and sample data. Kaplan-Meyer curves[23] were employed to estimate survival probabilities. To compare survival curves, the Log-rank test and empirical Hazard function were used. The event of death was considered after confirmation by autopsy, the data of which was registered in the patient's hospital records or was obtained by telephoning the relatives of the deceased. Surviving patients, who did not return to the outpatient's clinic within three months after release from hospital, were also contacted by telephone to check on their health. The level of statistical significance was set at 0.05.

RESULTS

A total of 712 cases were considered however only 681 filled the inclusion criteria of this study. Of these, 406 (59.6%) were men (p-value=0.001). The ages had a non-Gaussian bimodal distribution with peaks for patients within the first year of life and for those between 50 to 70 years old. The average age was 42 years old (range: 1 day to 96 years old – Fig 1).

The data of 48 (7%) cases were not updated from the

Fig 1. Distribution of the patients who underwent E-EEG.

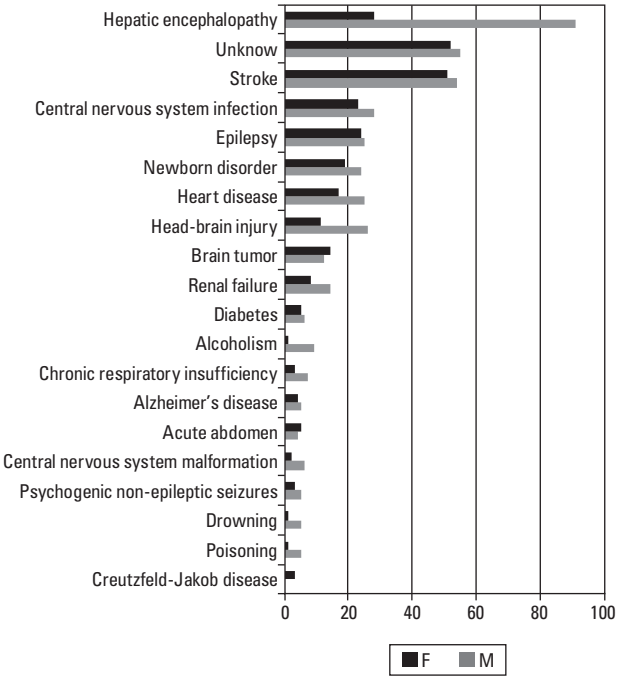

Fig 2. The main diseases found correlated with gender;*p-value= 0.001

patients records or by telephone) in the three months following the last day for patient enrollment (1/8/2007).

The reasons to perform emergency EEGs are shown in Table.

The underlying disease was elucidated in 578 (84.3%) of the participating patients whose main diseases are shown in Figure 2. Among the 119 (17.5%) patients who suffered hepatic encephalopathy, 26 (21.9%) presented with triphasic waves.

The survival curves of the ten most common electroencephalographic findings are shown in Figure 3.

DISCUSSION

The current study was designed to evaluate survival in respect to emergency EEG findings of patients examined in a tertiary general hospital. Performing emergency EEGs is feasible[24] however subject to many artifacts as was commented in the excellent review article published by Kaplan[25]. To reduce artifacts, ICUs have been adapted to local specifications with adequate earthing being provided for the apparatuses. Even so, whenever possible, when there was no risk of life, the patients were transferred either in wheel chairs or on stretchers to the neurophysiology laboratory.

The first interesting data found in this study was that

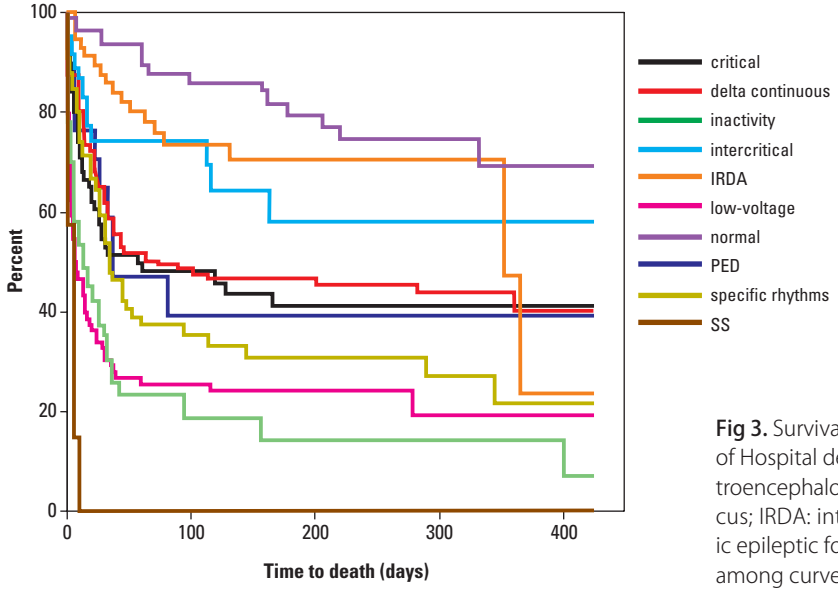

Fig 3. Survival curve of patients attended in emergency units of Hospital de Base according to the ten most common electroencephalographic finding. Critical: critical activity epilepcticus; IRDA: intermittent rhythmic delta activity; PED: periodic epileptic form disorder; SS: burst-suppression. Relationship among curves p-value=0.001.

Table. Reasons to perform the E-EEG correlated to gender (n=681).

	M*		F**	
Reason	**n**	**%**	**n**	**%**
Seizure	131	59.3	90	40.7
Hepatic encephalopathy#	85	73.3	31	26.7
Reduction in awareness	49	62.8	29	37.2
CSE[1]	45	46.4	52	53.6
Coma	21	53.8	18	46.2
CRA[2]	25	60	10	40
Brain death	14	66.7	7	33.3
Stroke	6	64.7	11	35.3
Mental confusion	6	37.5	10	62.5
Miscellanea[3]	7	50	7	50
Encephalitis	7	63.6	4	36.4
HBI[4]	7	63.6	4	36.4
PNEE[5]	3	60	2	40
Total#	406	59.6	275	40.4

[1]convulsive status epilepticus; [2]cardiorespiratory arrest; [3]apnea, Parkinson disease, abstinence, tremor, poisoning; [4]head-brain injury; [5]psychogenic non-epileptic event. *male; **female; #p-value<0.001.

the percentage of male patients was significantly higher than female patients. The explanation for this is that the study sample included a high number of patients with encephalopathy due to alcoholic cirrhosis; men are more prone to alcoholism. Another reason for there being more men in this study was the high rate of brain-encephalic injuries caused by motorbike accidents, which, in our region, are generally driven by young men.

In the studies by Hesdorffer et al.[10] in Rochester, USA and by Coeytaux et al.[26] in Switzerland, more men than women were attended with status epilepticus (SE), however in the current study the percentages of men and women with this condition are practically equal. There was no statistical difference between the genders of patients who underwent emergency EEG for impaired consciousness to confirm non-convulsive status epilepticus.

The distribution of the ages presented a bimodal aspect with the first peak being within the first year of life and the second between 50 and 70 years old. The peaks occur exactly at ages when individuals have greater vulnerability due either to the severe diseases of childhood or the fatal illnesses that affect adults in Brazil including heart and brain diseases. In this study, the relatively high number of severely ill children of up to one year old is due to the hospital being a regional reference center for surgeries to correct congenital heart disease.

All patients with isoelectric EEGs were declared dead on the day of the examination, as this is the last test in the brain death protocol for organ transplantation. Of the 21 patients with requests to certify brain death, 6 deaths were confirmed by EEG, while the others, who demonstrated low-voltage activity without the electroencephalographic criteria of brain death, were referred for brain arteriography or scintigraphy. One patient with an isoelectric EEG underwent this examination because of coma.

Considering the order of the EEG findings in decreasing severity, the group with the highest death rate comprised patients with burst-suppression, of which three quarters died before the end of the first month. This electroencephalographic finding occurred in particular as a consequence of anesthetics (midazolam, fentanil and barbiturates) during the treatment of SE and of anoxia caused by cardiorespiratory arrest, although in this study there were some cases due to other serious lesions of the central nervous system such as head-brain injury and intra-parenchymatous hemorrhages. In respect to the dismal prognosis, the data reported here are similar to other publications[1,27] with only 15% surviving after the third month.

The low-voltage, slow, nonreactive EEG group also presented low survival rates, with approximately three quarters having died by the second month after the examination. Similar to the findings of Celesia et al.[28], patients with cardiorespiratory arrest and patients with suspicion of brain death were the most common with this pattern. Additionally, as was described by Young[1] and Püttgen and Geocadin[29], this electroencephalographic pattern may occur within the first hours after anoxia owing to prolonged cardiorespiratory arrest and after evolving to a burst-suppression pattern[30].

The current study, unlike that by Young[1], found a low survival rate for patients in alpha, theta and spindle comas; by the end of the second month, almost two thirds of the cases in this group had already died. These results are in agreement with the findings of Kaplan[31]. In the current study the majority of alpha and theta comas originated in patients with cardiorespiratory arrest, while spindle comas originated in cases of intoxication by poison or medications. Comparable to the results found in other publications[6,32], spindle comas had a better prognosis than alpha and theta comas.

Continuing in order of decreasing severity, the PED-type electroencephalographic pattern was found in several patients, principally those with myoclonus encephalopathies after anoxia, prion diseases (three Creutzfeldt-Jakob cases)[32] and encephalitis. After the second month a few more than two fifths survived. Triphasic waves were not considered PEDs, although, sometimes, the distinction is difficult.

Patients with the ictal electroencephalographic pattern presented with intermediate survival among the studied groups, but even so, mortality was considerably high, as by the end of the second month, half the patients had died. The mortality rate is high due to the underlying disease and the seriousness inherent in SE because of the

excessive release of catecholamine which is the mechanism responsible for death[33]. In the current work, EEGs with PLED were grouped with the ictal pattern EEGs, in particular when there were clinical indications of seizures, although there is still controversy about the epileptiform nature of this discharge[34]. Triphasic waves were also analyzed with much care as they may appear in common clinical situations such as epileptic seizures or in encephalopathies, a situation that was explained well in the report of Kaplan and Birbeck[35]. These authors showed the difficulties in distinguishing between encephalopathy and non-convulsive status epilepticus in a series of seven patients intoxicated by lithium and individuals with myoclonic SEs after cerebral anoxia. EEGs critical to complex partial non-convulsive status epilepticus are difficult to identify given the variability in presentation, as was shown by Kaplan[36] and Markand[37]. In the current study, this difficulty was minimized by studying clinical findings and the behavioral phenomenology of the patient.

Another group in which half the patients died up to the end of the second month in this study is that of continuous delta rhythm. This group basically comprises patients with hepatic encephalopathy due to cirrhosis and who are waiting for liver transplantation. The EEGs of one fifth of these patients, apart from having slow activity, presented triphasic waves[6,29].

The group of patients with normal baseline rhythm EEGs and intercritical epileptiform disorders, and those with IRDA, which are the first manifestations of involvement of the central nervous system, have similar survival rates and correspond to patients with encephalopathies associated to underlying diseases that have good evolutions, including epilepsy, meningitis and head injuries.

As was reported in review articles by Young[1], Markand[37], Kaplan[2] and Nishisaki et al.[38] the prognosis and the survival rate of patients submitted to emergency EEGs depends on the underlying disease. Hence, the main findings of emergency EEGs were capable of differentiating the different survival rates in the sample studied and is thus a good prognostic tool for patients attended in hospital emergency units.

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