

# The encephalogram as a risk predictive test for work at height

O encefalograma como exame preditor de risco para trabalho em altura

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**ABSTRACT | Background:** Regulating standard 35 (NR-35) defines work at height as “any activity performed two meters above from ground level and involving risk of falls” and recommends the performance of medical examination to detect “conditions that might cause sudden loss of consciousness and falls from heights”. As a result many occupational physicians began to recommend routine electroencephalogram (EEG) to assess employees working at height. However, the validity of EEG for asymptomatic workers is uncertain. **Objective:** To analyze occupational accidents related to work at height occurring from January 1, 2000 to December 31, 2014, at a university hospital, and to correlate them with the results of EEGs performed along that period. **Methods:** Cross-sectional study involving review of EEG test, s clinical-occupational records and Work Accident Reports (WAR) of all employees working at height from January 1, 2000 to December 31, 2014. Terms in the WAR descriptions were established to investigate the relationship of accidents with “sudden loss of consciousness and falls from heights”, such as “fall from a height”, “sudden ill feeling”, “loss of consciousness”, “vertigo”, “dizziness” and “syncope”. EEG results were classified in three categories: normal, non-epileptic abnormalities and epileptic patterns. WAR descriptions were correlated with EEG results. **Results:** From 2,464 WARs issued along the investigated period, 2,228 were excluded because they did not correspond to work at height. From the remaining 236 WARs, 61 were excluded because EEG was not performed, therefore, 175 cases were included for analysis. Among the EEG tests assessed, 171 were normal, 4 exhibited non-epileptic abnormalities and none an epileptic pattern. Among all the analyzed cases, 13 descriptions included terms such as “fall from height”, “loss of consciousness”, “sudden ill feeling”, “vertigo”, “dizziness” and “syncope”; all the corresponding cases had normal EEG. **Conclusions:** EEG was not a good predictor of risk for accidents related with work at height in the analyzed sample. EEG should not be performed for assessment of asymptomatic workers, but only in cases with clinical suspicion of neurological abnormalities.

**Keywords |** occupational accidents; occupational accident reporting; syncope; vertigo; electroencephalogram.

**RESUMO | Contexto:** A Norma Regulamentadora 35 (NR-35) define trabalho em altura como “qualquer atividade executada acima de dois metros do nível inferior, onde haja risco de queda”, e propõe que sejam realizados exames médicos voltados “a patologias que poderão originar mal súbito e queda de altura”. Muitos médicos do trabalho passaram a solicitar o eletroencefalograma (EEG) de rotina para trabalhadores que exercem trabalho em altura. No entanto, a validade desse exame para trabalhadores assintomáticos é discutível. **Objetivo:** Analisar os acidentes de trabalho relacionados a trabalho em altura ocorridos entre 1º de janeiro de 2000 e 31 de dezembro de 2014 em um hospital universitário, correlacionando-os ao resultado dos EEGs realizados no mesmo período. **Métodos:** Trata-se de estudo transversal com revisão de EEGs, prontuários clínico-ocupacionais e Comunicações de Acidente do Trabalho (CATs) de todos os trabalhadores que exerceram trabalho em altura entre 1º de janeiro de 2000 e 31 de dezembro de 2014. Foram definidos termos na descrição da CAT para avaliar a relação do acidente com “mal súbito ou queda em altura”, como “queda”, “perda da consciência”, “mal súbito”, “vertigem”, “tontura” e “síncope”. Os EEGs foram classificados em três categorias, de acordo com os resultados: normais, com alterações inespecíficas ou com alterações epileptogênicas. Foram correlacionadas as CATs com os resultados dos respectivos EEGs.

Study performed at Clinical Hospital of Porto Alegre (Hospital de Clínicas de Porto Alegre – HCPA) - Porto Alegre (RS), Brazil.

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**Resultados:** De 2.464 CATs emitidas no período, 2.228 foram excluídas por não serem de trabalhadores em altura. Das 236 CATs restantes, 61 foram excluídas por não haver pelo menos 1 EEG realizado nos respectivos trabalhadores. Entre os 175 acidentes restantes, observou-se 171 EEGs normais e 4 com alterações inespecíficas; nenhum dos exames apresentou alterações epileptogênicas. Entre esses 175 acidentes, 13 traziam em sua descrição termos como “mal súbito ou queda em altura”, como “queda”, “perda da consciência”, “mal súbito”, “vertigem”, “tontura” e “síncope”. Entre os 13 acidentes, nenhum EEG apresentou alterações. **Conclusão:** O EEG não foi um exame preditor de risco de acidente envolvendo trabalho em altura entre os trabalhadores avaliados no período. O EEG não deve ser utilizado para trabalhadores assintomáticos, e só deve ser realizado quando houver indicação clínica.

**Palavras-chave** | acidentes de trabalho; notificação de acidentes de trabalho; síncope; vertigem; eletroencefalograma.

## INTRODUCTION

Several human activities depend on work performed at a height, from the most simple, like changing a streetlamp, to the most complex, like assembling a scaffold, façade cleaning, boiler maintenance, electrical installations and oil extraction. According to Regulatory Standard no. 35 (NS-35) work at height is defined as “any activity performed two meters above ground level and involving risk of falls<sup>1</sup>.”

Work at height involves risk, the main types being:

- elevated falls;
- same-level falls;
- fall of things.

At Clinical Hospital of Porto Alegre (Hospital de Clínicas de Porto Alegre — HCPA) the job positions which include activities that involve work at height are the ones of:

- hydraulic technicians;
- maintenance technicians;
- electricians;
- construction workers;
- bricklayers;
- maintenance assistants;
- mechanical workers;
- metalworkers;
- carpenters;
- plumbers;
- painters.

NS-35 made mandatory for occupational safety and health services at companies to meet the requirements relative to protective measures for work at height<sup>1</sup>. This involves planning, organization and execution to

ensure the safety and health of workers who perform this type of work.

In regard to the health of workers who perform work at height, NS-35 recommends performing medical examinations to detect “conditions that might cause blackouts and falls from heights<sup>1</sup>.”

There are many definitions for blackout in the literature, ranging from sudden and transient loss of consciousness to epilepsy, dizziness, vertigo and syncope<sup>2,3</sup>. While blackout is a common complaint among patients who visit medical services, the lack of an unequivocal definition<sup>2</sup> impairs their assessment, management and diagnosis.

Along the investigation and follow up of patients with sudden and transient loss of consciousness, many specialists request an electroencefalogram (EEG) seeking to detect previously unknown neurological problems among individuals who perform work at height to prevent the occurrence of blackouts<sup>3</sup>.

EEG is a test that graphically represents the brain electrical activity<sup>3</sup>. It was first employed in 1929 by the neuropsychiatrist Hans Berger<sup>4</sup>. From that time onward, the EEG improved much toward the obtainment of the best graphic records possible, i.e., free from artefact, which is due to:

- eye movements;
- muscle contraction;
- perspiration;
- infusion equipment;
- infusion pumps;
- cardiac pacemakers.

In addition, the EEG patterns might vary according to age and the physiological sleep-wake cycle<sup>4,6</sup>.

As to its applications, EEG is used for diagnosis, follow up and establishment of the prognosis of patients with epilepsy<sup>3</sup>. However, even when performed under satisfactory technical conditions, EEG might fail to record epileptic seizures<sup>7</sup>. This explains why it does not have 100% of sensitivity and specificity, whence normal results do not rule out a diagnosis of epilepsy<sup>7,8</sup>. In addition, about 8% of the patients with clinically confirmed epilepsy do not exhibit any abnormality on EEG, even when techniques that increase its sensitivity are used<sup>7,8</sup>.

As is known, in cases with strong clinical suspicion of epilepsy, based on the clinical interview or direct observation of seizures, the odds for EEG to evidence abnormalities supporting the diagnosis are high<sup>2,5,9,10</sup>. However, when the clinical suspicion is weak, EEG hardly helps elucidating the patient's condition, and thus it is not indicated<sup>2,9,10</sup>. It is even less indicated for patients without any symptom, because the incidence of abnormalities on EEG among asymptomatic individuals might vary from 0.1% to 10%<sup>7,8,10</sup>. Such wide variation is due to factors poorly investigated in the course of the clinical interview, including history of head injury, drug abuse and migraine<sup>2,10</sup>, among others.

According to some studies, EEG is not adequate to assess asymptomatic patients as a function of its low sensitivity and specificity<sup>8</sup>. For this reason we decided to analyze HCPA employees who perform work at height and had undergone at least one EEG test to investigate the correlation between EEG results and occurrence of work accidents.

After NS-35 was passed in March 2012, many companies included EEG among the tests used to assess occupational risk in association with work at height. However, up to the present time there is no scientific study that justifies such measure.

The aim of the present study was to analyze occupational data of employees who perform work at height at a general hospital in Rio Grande do Sul, Brazil, gathered along a 15-year period to investigate the correlation of occupational accidents possibly related with work at height and abnormalities on EEG.

## METHODS

The present cross-sectional observational study analyzed the prevalence of occupational accidents related with work

at height at HCPA and the occurrence of EEG abnormalities among the involved employees.

We first reviewed all Work Accident Reports (WAR) issued by the HCPA Occupational Medicine Service (OMS) from 1 January 2000 to 31 December 2014. Only the WARs corresponding to employees who perform work at height were included for analysis, namely:

- hydraulic technicians;
- maintenance technicians;
- electricians;
- construction workers;
- bricklayers;
- maintenance assistants;
- mechanical workers;
- metalworkers;
- carpenters;
- plumbers;
- painters.

This review allowed us identify words “fall” and/or “blackout” in the descriptions of accidents.

Next we reviewed paper and electronic records, the latter stored in STARH and AGHWEB systems, which include the employees' registration, clinical and occupational data. For all cases in which WARs included words “fall” and/or “blackout” we analyzed the EEG results, which were categorized as normal, with unspecific abnormalities or epileptogenic abnormalities.

All HCPA employees likely to perform work at height until 31 December 2014 and having performed at least one EEG test were included in the study.

The data were analyzed using software SPSS to investigate the presence of statistical correlations. Sensitivity was calculated considering the number of abnormalities on EEG of workers who had had falls. In turn, to calculate specificity we considered the number of tests without any abnormality, i.e., normal, and the tests which descriptions lacked the aforementioned words.

## RESULTS

From 2,464 WARs issued from 1 January 2000 to 31 December 2014, 2,228 were excluded because they did not correspond to employees likely to perform work at

height. From the remaining 236 WARs, we only analyzed the ones corresponding to employees who in addition to being exposed to work at height had performed at least one EEG test, the number of whom was 175.

From this group of 175 WARs, we found word “fall” in 13 and “blackout” in none.

Next we reviewed the results of the EEG performed for the 175 employees likely to work at height. A total of 171 (97.7%) were normal, 4 (2.3%) exhibited unspecific abnormalities and none epileptogenic abnormalities.

Relative to the 13 WARs that mentioned word “fall” in the description of the accident, all the EEG tests were rated normal (Table 1).

A total of 175 WARs were issued for employees allocated to 11 job positions involving work at height, distributed as following:

- 72 (41.1%) WARs issued for mechanical maintenance technicians;
- 10 (5.7%) WARs issued for metalworkers;
- 35 (20.0%) WARs issued for carpenters;
- 8 (4.6%) WARs issued for plumbers;
- 11 (6.3%) WARs issued for construction workers;
- 9 (5.1%) WARs issued for painters;
- 9 (5.1%) WARs issued for bricklayers;
- 4 (2.3%) WARs issued for hydraulic technicians;
- 6 (3.4%) WARs issued for maintenance assistants;
- 5 (2.9%) WARs issued for mechanicals (Figure 1).

The employees’ age varied from 24 to 68 years old, mean 45.4 years old.

The positive predictive value was 0, the negative predictive value 0.924 and accuracy 0.903.

## DISCUSSION

Along a period of about 15 years, none of the employees who had suffered falls exhibited abnormalities on EEG, i.e., this test was unsatisfactory for the screening of blackout among asymptomatic individuals who perform work at height. None among the 13 employees who had had falls exhibited any abnormality on EEG. In turn, none among the four employees with unspecific abnormalities on EEG had recorded falls and/or blackouts along the analyzed period.

In the present study the specificity of EEG was high, since 171 out of the 175 analyzed employees exhibited no abnormalities and had not suffered falls.

## CONCLUSION

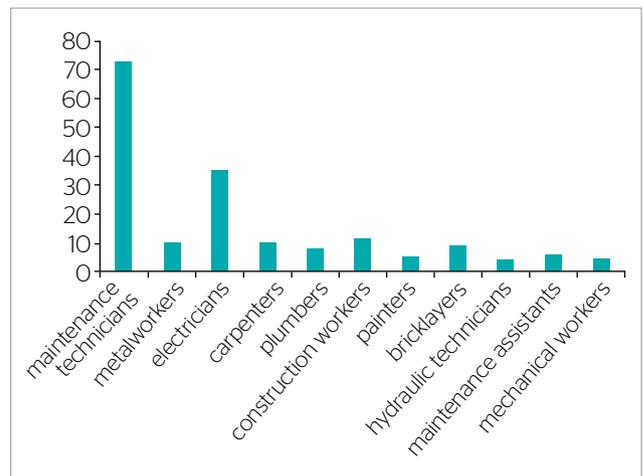
Based on the results of the present study, we might conclude that none among the analyzed employees exhibited epileptogenic abnormalities on EEG along the analyzed period, and that unspecific abnormalities on EEG were not associated with risk of falls. No occurrence of accidents was clearly correlated with blackout due to epilepsy.

Although many companies included EEG in the assessment of risk among asymptomatic employees who perform work at height, this test is indicated only for cases in which

**Table 1.** Comparison of electroencephalogram results of employees who suffered falls.

EEG results	Falls		
	Yes	No	Total
Normal	13	158	171
Unspecific abnormalities	0	4	4
Epileptogenic abnormalities	0	0	0
Total	13	162	175

EEG: electroencephalogram.



**Figure 1.** Correlation between number of issued Work Accident Reports and occupational category.

clinical manifestations indicate its use. Few studies analyzed EEG as predictor of occupational risk specifically for individuals who perform work at height.

The present study corroborates the technical guideline published in September 2015 by the National Association of Occupational Medicine (Associação Nacional de Medicina do Trabalho — ANAMT) which does not recommend EEG for the screening of epilepsy in occupational medicine practice<sup>11</sup>.

Although many Occupational Health Medical Control Programs (Programas de Controle Médico de Saúde

Ocupacional — PCMSO) suggest EEG for individuals who perform work at height, the results of the present study indicate it is not a predictor of risk of blackout for this population of workers. Additional assessment through further studies on this subject is needed.

We should also emphasize that the implementation of work environments that ensure the physical integrity of employees, as well as of safety measures afford protection against hazards that might result in work accidents<sup>12</sup>.

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