Can Natural Disasters Increase the Risk of Stroke?

Desastres Naturais Podem Aumentar o Risco de AVC?

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ABSTRACT

Introduction: Natural disasters occur more and more frequently. In 2008, the cities of Itajaí Valley were hit by flooding of large proportion associated with landslides. Objective: To evaluate the frequency of cases of cerebrovascular disease (CVD) admitted to the Hospital Santa Isabel de Blumenau (HSI) in three periods and its possible relationship with the natural disaster occurred in November 2008. Method: CVD cases were selected among inpatients in the HSI in Period I: 2007 to 2008, Period II: 2008 to 2009 (period of natural disaster) and Period III: 2009 to 2010. Results: There was an increase in the absolute number of CVD cases over the three periods (32, 56 and 77, respectively). In the year of the disaster a significant elevation of the numbers of cases of CVD was seen. Conclusion: Statistically significant increase in the frequency of CVD after the natural disaster of November 22nd, 2008 could be considered as implication of correlation.

Key words: Natural disaster; Catastrophe; Cerebrovascular disease; Stroke

INTRODUCTION

World’s exposure to traumatic events, particularly natural disasters, has been increasing in frequency – especially in developing countries. Possible explanations for this observation include the increase in population, in conjunction with poor living conditions, as well as the intense process of urbanization and industrialization.1-3. Noting this escalation of natural disasters is extremely important, especially due to their direct consequence in people’s health. Therefore, natural hazards have become, in fact, a public health issue.

Cities within the “Itajaí Valley”, especially Blumenau, have a history marked by several flooding disasters. In this context, we highlight the flood of the Itajaí River and consequent landslides that occurred on November 22nd, 2008. This natural disaster not only affected the cities located within the “Itajaí Valley” but actually virtually every city in the premises of the Middle Valley of Itajaí. As a result, solely in the city of...
Blumenau, there were 23,535 residents who were displaced by the flooding, 18,150 damaged residences, and 24 deaths.

Stroke is the fifth leading cause of death in the United States, behind heart disease, cancer, respiratory diseases, and accidents. Female stroke incidence rate is 60.6%, whereas male stroke incidence rate is 39.4%. Despite the strong epidemiological data on stroke, the association between stroke and natural disasters has never been reported. Worldwide, stroke corresponds to 9% of all deaths, and the second most common cause of death after heart ischemic disease. In Brazil, stroke accounted for 87,344 deaths in the year of 2002 - considering all types of stroke -, while coronary heart disease led to 81,505 deaths.

Stroke can be sub-classified in ischemic stroke, intracerebral hemorrhagic stroke and subarachnoid bleeding. In North America, according to the American Heart Association Statistics Committee and Stroke Statistics Subcommittee heart disease and stroke statistics (2011), 87% of strokes were ischemic, 10% were intracerebral hematomas and 3% were subarachnoid bleeding.

Several modifiable risk factors for the development of stroke have been described, including smoking, atrial fibrillation, SAH, and depression. In terms of mortality, a quarter of patients affected by stroke are estimated to die within a month, one-third in six months and half in one year. Patients who survive may develop several comorbidities, such as motor impairment, dementia, heart complications, pneumonia, venous thromboembolism, fever, musculoskeletal pain, dysphagia, depression, urinary and fecal incontinence. As a consequence, this disease generates large expenses, consuming about 2 to 4% of the total cost of medical care in the world.

Herein we intend to seek for a possible relationship between flooding and the incidence of stroke, such as the one described by Sokejima et al. regarding earthquakes. Once a relationship is confirmed, it will certainly help health authorities to plan supportive measures in the setting of natural catastrophes/flooding, to minimize stroke occurrence and, as a consequence, its burden.

**METHODS**

This cross-sectional study was conducted at the Hospital Santa Isabel (HSI), Blumenau, in Southern Brazil. The project was approved by the local regulatory committee before initiation. Data from patients with a diagnosis of stroke within the following categories of ICD: I 60 (subarachnoid hemorrhage), I 61 (intracerebral hemorrhage), I 63 (cerebral infarction) and I 64 (unspecified stroke, as hemorrhagic or ischemic) was collected and analyzed based on three timepoints: Pre-Flood Period (from October 22nd, 2007 to January 22nd, 2008), Flood Period (October 22nd, 2008 to January 22nd, 2009) and Post-Flood Period (October 22nd, 2009 to January 22nd, 2010). Aiming to avoid errors related to stroke seasonality, measurements were done in equal time intervals for each period.

The Flood Period was subdivided into: flood period A, immediately preceding the catastrophe (from October 22nd to November 21st); flood period B, the day and month subsequent to the catastrophe (from November 22nd to December 21st); and flood period C, the following consecutive month (from December 22nd to January 22nd).

Clinical and neuroimaging (CT and/or MRI) diagnosis of stroke were necessary for inclusion. This data was retrieved from the hospital records by chart reviewing. Only new cases were included, and cases of hospitalization due to other condition(s) were excluded from the analysis.

The patients who were included in this study were necessarily from cities within the “Itajaí Valley” that decreed state of public calamity and emergency situation on the occasion of the natural disaster on November 22nd, 2008. Data was obtained from electronic records (TASY-Weh systems); the retrieved clinical variables were the following: age, sex, origin, smoking, dyslipidemia, diabetes mellitus, SAH and death. Mortality rates were obtained from DATASUS, a health indicator of the Brazilian Health Ministry, following the same criteria used for the data collection from electronic records.

Data was encoded and recorded on Microsoft® Excel 2007 and analyzed with the OpenEpi® software, through the Chi square test for proportions and ANOVA for averages. Statistical significance level was considered for $p \leq 0.05$. 

RESULTS

A total of 165 cases, divided as depicted in Figure 1, were selected in the periods surveyed, as follows: pre-flood period, prior to the disaster; flood period, year of disaster; and post-flood Period, subsequent to the disaster.

The 165 cases included in this study were subdivided into the three surveyed periods: Pre-Flood Period (32 patients), Flood Period (56 patients), and Post-Flood Period (77 patients). This division was delimited to three months of the previous and the year after the incident to avoid stroke systematic distortion. Ninety patients (54.55%) were men and 75 (45.45%) women. The mean age was 61.52 (± 15.51) years and the median age 62 years, with no statistically significant difference between the three time periods.

In the pre-flood period, 18 events of STROKE were recorded in the pre flood period A, eight in pre flood period B and six in the pre flood period C. In the flood period, there were 14 events in the flood period A, 15 events in flood period B and 27 events in the flood period C. Twenty-seven cases occurred in the post flood period A, 27 post flood period B and 23 in post flood period C.

Figure 2 depicts the evolution of the STROKE types per period. It was noted in the sum of the three periods a total of 109 ischemic strokes (66.06%), 15 intracerebral hematomas (9.09%), 34 subarachnoid hemorrhages (20.61%), and 7 indeterminate cases (4.24%) - all of which occurred in the first period.

Among all patients in this study, 66.06% were from Blumenau (17, 37 and 55 in the pre flood, flood and post flood period, respectively) and 33.94% from other cities affected by the disaster (15, 19 and 22 in the pre-flood, flood and post-flood period, respectively).

Table 1. Periods and Chi square test.

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<tr>
<th></th>
<th>Chi square test with no correction</th>
<th>Chi square test with Yates' correction</th>
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<tr>
<td>Flood period B</td>
<td>10.39</td>
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Figure 1. Number of patients affected by STROKE, per period.
RISK FACTORS

In our sample, smoking was reported in 25.45% of the cases, absent in 9.09% and not recorded in 65.45%. Diabetes mellitus was reported in 26.06%, absent in 10.91% and not reported in 63.03%. Dyslipidemia was identified in 23.64%, absent in 6.67% and not informed at 69.7%. SAH was present in 62.42% of cases, absent in 5.45% and not available on 32.12% of patients.

COEFFICIENT OF MORTALITY AND DEATHS

Twenty-nine deaths were registered with a mortality of 17.58%, 51.72% men and 48.28% women, with deaths and lethality by period illustrated in Figure 3.

Mortality data of cities from the “Itajai Valley” is represented according to DATASUS records (Figure 4).

DISCUSSION

According to the American Heart Association Statistics Committee and Stroke Statistics Subcommittee, men are slightly more affected by stroke compared to women, data that is in agreement with our findings (55.44% men and 45.45% women).

The average age found in our study was 61.52 years of age, with a standard deviation of 15.51. These figures are similar to studies conducted in Buenos Aires (Argentina) and
Santiago (Chile), which found an average age 62 and 64 years respectively. In our series, 66.06% of the cases were ischemic stroke, 9.09% hemorrhagic stroke and 20.61% subarachnoid hemorrhages. These values differ from the standard numbers reported by the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Our findings on the prevalence of the various types of stroke types are not consistent with that described in the literature, probably due to the fact that the Hospital Santa Isabel of Blumenau is a reference center for endovascular treatment of SAH.

While surveys point to a decrease in the number of stroke cases consistently along the years, our study shows an increase in the number of cases over the periods surveyed. As previously described in the results, an increase in the number of cases of stroke was found during the period I to period II bracket, especially the ischemic type. This relationship, which is statistically significant ($p = 0.0059$), leads us to hypothesize that the exposure to the catastrophe was related with an increased frequency of stroke.

Focusing on the flood period A and B, which correspond to the month preceding the month of the disaster and the month of the catastrophe, we noticed that despite the slight increase in the absolute number of cases (14 to 15 cases), it was not statistically significant ($p = 0.1191$). This $p$-value does not allow us to affirm that the acute stress arising from the catastrophe is correlated to the development of stroke. A possible explanation for this fact is the limitation of access to hospitals due to numerous barriers falls, flooded areas and broken bridges.

Comparing the flood period A and C, it is notorious the statistically significant ($p=0.0011$) increase in the absolute number of cases (from 14 to 27 cases), which supports that the exposure to catastrophe and its effects over time constitute a positive relationship to the development of stroke. This increase may also be explained by: 1) the development of post-traumatic stress syndrome, triggered by the catastrophe; 2) the disorganization in providing decent support to the population during and after the natural disaster; and 3) lack of primary health care during and after the flooding, which could have resulted in poor control of stroke risk factors (especially important in the development of SAH. Regarding the latter, we highlight the elevation in blood pressure, which is expected in the context of major disasters and lack of proper health care, and that is an extremely important risk factor for SAH. As consistently reported in the literature, situations of stress can activate the hypothalamic-pituitary-adrenal glands, generating an adrenergic response and consequent hyperactivation of the whole sympathetic nervous system.

Furthermore, recent studies show that mental stress can lead to a reduction in the activity of tissue plasminogen activator, increased platelet activation and blood viscosity, which ultimately generate a hypercoagulable state. Additionally, there may be an acute reduction in the circulating plasma volume and rupture of vulnerable atherosclerotic plaques.

Similarly, we found a significant increase in the number of cases in the pre and post flood period, also arising from the increase in the number of cases of ischemic stroke. This relationship was also statistically significant ($p = 0.0002$), which allows us to hypothesize a temporal relationship between the disaster occurrence and the increase in the number of cases of cardiovascular disease, particularly ischemic stroke.

This incidence may also be explained by inadequate care and control of chronic diseases, such as the interruption in medication use, and excessive physical exertion in the scenario of a major disaster. Moreover, the development of post-traumatic stress syndrome, triggered by emotional stress (such as death of a loved one or resident displacement), may additionally contribute to the increase in stroke incidence. In this regard, during the natural disaster described herein more 18 thousand homes were damaged, which forced thousands of people to seek for temporary shelters.

This study should be a warning to the public health authorities about the topographies vulnerable to this kind of catastrophe. Further studies should be conducted in an attempt to confirm and validate our results and hypotheses.

### References

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