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Clinical Study

The Christchurch earthquake stroke incidence study

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ABSTRACT

We examined the impact of major earthquakes on acute stroke admissions by a retrospective review of stroke admissions in the 6 weeks following the 4 September 2010 and 22 February 2011 earthquakes. The control period was the corresponding 6 weeks in the previous year. In the 6 weeks following the September 2010 earthquake there were 97 acute stroke admissions, with 79 (81.4%) ischaemic infarctions. This was similar to the 2009 control period which had 104 acute stroke admissions, of whom 80 (76.9%) had ischaemic infarction. In the 6 weeks following the February 2011 earthquake, there were 71 stroke admissions, and 61 (79.2%) were ischaemic infarction. This was less than the 96 strokes (72 [75%] ischaemic infarction) in the corresponding control period. None of the comparisons were statistically significant. There was also no difference in the rate of cardioembolic infarction from atrial fibrillation between the study periods. Patients admitted during the February 2011 earthquake period were less likely to be discharged directly home when compared to the control period (31.2% *versus* 46.9%, $p = 0.036$). There was no observable trend in the number of weekly stroke admissions between the 2 weeks leading to and 6 weeks following the earthquakes. Our results suggest that severe psychological stress from earthquakes did not influence the subsequent short term risk of acute stroke, but the severity of the earthquake in February 2011 and associated civil structural damages may have influenced the pattern of discharge for stroke patients.

1. Introduction

Christchurch is the second largest city in New Zealand. On 4 September 2010 at 4.35 am, a magnitude 7.1 (Richter scale) earthquake struck 40 kilometres (km) west of Christchurch at a depth of 10 km. The earthquake caused extensive structural damage and power outrages but was without fatalities. There have since been over 11000 aftershocks within the Christchurch region. It is difficult for those not involved in earthquakes to appreciate the experience caused by sudden unexpected jolts, especially large earthquakes. An earthquake of magnitude five or greater can render one incapable of escaping from a potentially dangerous situation for the duration of the earthquake. In addition to causing structural damage, the earthquakes can also induce acute anxiety and stress for those experiencing them [1]. There have been 50 aftershocks of magnitude five or greater (Fig. 1) since the 4 September 2010 earthquake [2].

The largest aftershock was the magnitude 6.3 quake on 22 February 2012 at 12.51 pm at a depth of 5 km centred 10 km south east of Christchurch City. This resulted in destruction of the central city with 185 deaths. A state of emergency was declared for 2 months and the rebuilding process continued past the end of 2012.

The effect of earthquakes on stroke occurrence has been examined in the aftermath of the 1995 Japanese Hanshin-Awaji earthquake. This study found an increase in stroke incidence in the first year following the initial earthquake [3]. In another Japanese study, there was an increase in the incidence of acute coronary syndrome and cerebral haemorrhage in the 35 days following the Noto Peninsula earthquake [4].

Psychological stress is a recognised trigger of stroke [5–6]. The triggering of stroke is a result of interplay between individuals at risk and a surge in sympathetic activity leading to rupture of a vulnerable plaque, platelet activation and cardioembolism from cardiac arrhythmias or stress cardiomyopathy [5,7–8]. The two studies that evaluated risk of stroke following exposure to severe earthquakes were based in small peripheral hospitals in rural Japan [3–4]. The aim of this study was to investigate the impact of the major earthquakes on the incidence of acute stroke at a large tertiary hospital.

2. Study methods

We reviewed the electronic discharge summaries and/or charts on patients diagnosed with acute stroke in the 2 weeks leading to

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and 6 weeks following the 4 September 2010 and 22 February 2011 earthquakes. Patients over the age of 15 years were identified electronically using International Classification of Disease 10 coding for acute stroke (codes I60–64, G46). Patients were excluded if there was no imaging available or diagnosis was unclear. For patients with more than one stroke during the study period only the first admission was used for data analysis. The control period was the corresponding period in the previous year.

Basic patient demographics, type of acute stroke, presence of atrial fibrillation (AF) in ischaemic stroke patients, length of stay in the acute hospital and discharge destination were collected. No informed consent was required from the patients as the data were anonymous and no patients were contacted.

2.1. Statistical analysis

We performed statistics using the online software OpenEpi [18]. We used the chi-squared test when appropriate.

3. Results

In the 6 weeks after the September earthquake there were 97 acute stroke admissions, and 79 (81.4%) were ischaemic infarction. Twenty-two (27.8%) of 79 ischaemic strokes patients had AF on admission. In the September control period there were 104 acute stroke admissions, 80 (76.9%) were ischaemic infarction, of whom 17 (21.3%) had AF. In the post-quake period following the February event there were 77 acute stroke admissions, 61 (79.2%) were ischaemic infarction and 24 (39%) had AF causing infarction. In the February post-quake control period there were 96 stroke admissions, 72 (75%) ischaemic infarctions, of whom 21 (29.2%) had AF. None of the differences were statistically significant. There was also no difference in the basic patient demographics or length of stay in the acute hospital. Table 1 summarises these findings.

With regards to discharge destination (Table 1), there was no difference the proportion of patients who were directly discharged home between the September patients and the respective control patients (36 [37.1%] *versus* 49 [47.1%], $p = 0.16$). There were significantly fewer February post-quake patients who were discharged directly home when compared with the respective control (24 [31.2%] *versus* 45 [46.9%], $p = 0.036$).

In terms of stroke admissions, there was no observable trend in the number of admissions between the 2 week lead-in period and the 6 week post-quake period (Fig. 2).

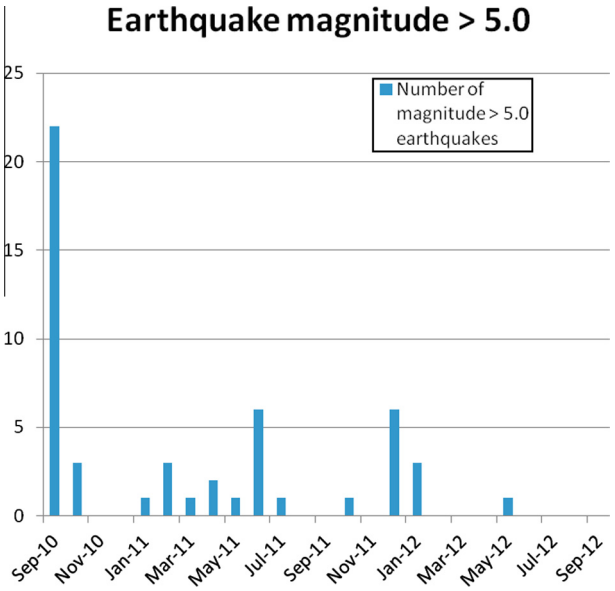

Fig. 1. Bar graph showing the number of earthquakes of magnitude >5.0 on the Richter scale in Christchurch, New Zealand between 2010 and 2012.

4. Discussion

Earthquakes are a source of extreme psychological stress [1] – a recognised trigger for acute cardiovascular events including strokes [5,9–10]. Our opportunistic study is the third and the largest earthquake related stroke incidence study to our knowledge. Our results suggest severe psychological stress of this nature does not trigger acute stroke.

Two previous hospital based Japanese studies suggested an increased risk of stroke following large earthquakes [3–4]. Sokejima et al. performed a retrospective cohort study on the incidence of stroke in adults greater than 40 years of age in two rural Japanese townships after the Great Hanshin-Awaji earthquake in 1995 [3]. They compared the stroke incidence in the year following the earthquake to control periods the year before and the second year after the earthquake. They found a significant increase in the incidence of stroke in the year following the earthquake (8.1/1000) when compared to the year before (5.1/1000) and the second year (5.6/1000) after the earthquake ($p = 0.03$ for comparisons) [3]. The risk of stroke was correlated with the degree of seismic activity.

Table 1
Patient demographics, stroke subtypes and discharge outcome following earthquakes in Christchurch, New Zealand

	September 4 earthquake	September control	*p* value*	February 22 earthquake	February control	*p* value*
Total strokes	97	104	–	77	96	
% of total annual strokes	8.4%	9.6%	0.32	6.71%	8.3%	0.16
Male	44 (45.4%)	57 (54.8%)	0.18	42 (54.5%)	50 (52.1%)	0.75
Ischaemic strokes	79 (81.4%)	80 (76.9%)	0.44	61 (79.2%)	72 (75%)	0.52
Atrial fibrillation	22 (27.8%)	17 (21.3%)	0.43	24 (39%)	21 (29.2%)	0.17
Age (±SD)	74.9 (±12.5)	70.1 (±14.6)	–	73.6 (±14.5)	73.1 (±10.4)	–
Length of hospital stay (days)	6.6	7.25	–	6.5	6.5	–
Discharge destination						
Directly home	36 (37.1%)	49 (47.1%)	0.16	24 (31.2%)	45 (46.9%)	0.036
Other	61 (62.9%)	55 (52.9%)	–	53 (68.8%)	51 (53.1%)	–
Death	14 (14.4%)	13 (12.5%)	–	15 (19.5%)	11 (11.5%)	–
Rehabilitation	35 (36.1%)	37 (35.6%)	–	34 (44.2%)	32 (33.3%)	–
Institution	11 (11.3%)	5 (4.8%)	–	3 (3.9%)	5 (5.2%)	–
Other	1 (1%)	0	–	1 (1.3%)	3 (3.1%)	–

SD = standard deviation.
* *p* values calculated by chi-squared.