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RAPID COMMUNICATION

Three-Year Follow-up After the Great East Japan Earthquake in the Incidence of Out-of-Hospital Cardiac Arrest With Cardiac Origin

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Background: We assessed whether the occurrence of out-of-hospital cardiac arrest (OHCA) with cardiac origin increased in the disaster areas during the 3-year period after the Great East Japan Earthquake (GEJE).

Methods and Results: From the OHCA registry in Japan, yearly changes in occurrence after the GEJE were assessed by applying Poisson regression models. The risk ratio of the first year after the earthquake was significantly greater in both men and women, but the difference disappeared in the second and third years.

Conclusions: The GEJE significantly increased the occurrence of OHCA with cardiac origin in the first year after the earthquake.

Key Words: Cardiac arrest; Earthquakes; Epidemiology; Sudden death

Large-scale earthquakes are a risk factor for acute cardiovascular diseases.[1–5] Previous studies reported that out-of-hospital cardiac arrest (OHCA) with cardiac origin and cardiovascular death (CVD) increased during the acute phase after the Great East Japan Earthquake (GEJE), which struck with a magnitude of 9.0 on 11 March 2011,[6,7] but the long-term risks for cardiovascular events have not been extensively investigated. Using a nationwide OHCA database of Japan, we assessed the trends in the occurrence of OHCA with cardiac origin during the 3 years after the GEJE in the 3 prefectures (Fukushima, Miyagi, Iwate) that were the most damaged by the GEJE.[6] Our hypothesis was that the occurrence of OHCA with cardiac origin would continue to increase in the 3-year period after the GEJE.

Methods

Study Design, Settings, and Patients

In the All-Japan Utstein registry,[8] we included adult patients aged ≥20 years old suffering OHCA with cardiac origin, who were transported to medical institutions by emergency medical service (EMS) personnel in the 3 prefectures that were damaged most by the earthquake (**Figure**).[6,9] Cardiac arrest was defined as the cessation of cardiac mechanical activity confirmed by the absence of signs of circulation. The arrest was presumed to be of cardiac origin unless there was a definitive non-cardiac cause. These diagnoses were clinically determined by the physicians in charge, in collaboration with the EMS personnel. The study protocol was approved by the Ethics Committee of Osaka University. The requirement for informed consent was waived.

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Statistical Analysis

We divided the study period to calculate the incident risk of OHCA with cardiac origin every 1 year after the GEJE: reference year from 11 March 2010 to 10 March 2011, first year after the earthquake from 11 March 2011 to 10 March 2012, second year from 11 March 2012 to 10 March 2013, third year from 11 March 2013 to 10 March 2014. The risk ratios (RRs) and 95% confidence intervals (CI) for each period were estimated by Poisson regression model, adjusted for sex, age, and prefecture. RRs were also separately calculated by sex (male, female) and age (20–74 years, ≥75 years).[6] All statistical analyses were performed using STATA version 14.0MP software (Stata Corp., College Station, TX, USA).

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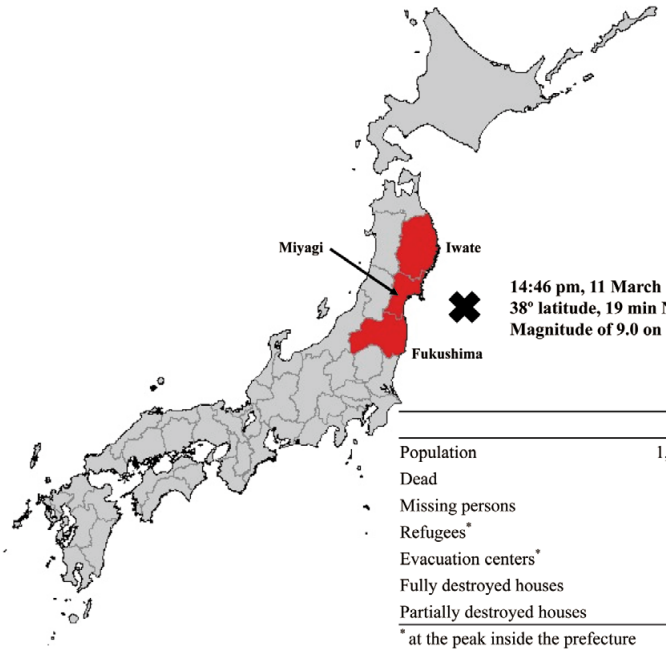

	Iwate	Miyagi	Fukushima
Population	1,330,147	2,348,165	2,029,064
Dead	4,673	9,540	1,614
Missing persons	1,122	1,228	196
Refugees*	54,429	320,885	73,608
Evacuation centers*	399	1183	410
Fully destroyed houses	19,507	83,001	15,224
Partially destroyed houses	6,570	155,129	80,793

*at the peak inside the prefecture

Figure. The Great East Japan Earthquake. The epicenter is shown with a cross, major disaster areas are in red. The table shows disaster damage by prefecture.

Results

The **Table** shows the trends in the occurrence of OHCA with cardiac origin before and after the GEJE. The RR of the first year after the earthquake was significantly greater in both men (1.07 [1.01–1.13]) and women (1.12 [1.05–1.19]), but the difference disappeared in the second and third years. In a subgroup analysis, the RR in the elderly population aged ≥75 years old significantly increased in the first year after the earthquake than in the reference year (1.13 [1.05–1.22] among men and 1.14 [1.06–1.22] among women), but the RRs did not change in the group aged 20–74 years old regardless of sex.

Discussion

In this study, the RR of the occurrence of OHCA with cardiac origin significantly increased in the disaster areas in the first year after the GEJE, especially in the elderly population, but these changes disappeared in the second and third years. This study investigated the OHCA occurrence during the 3-year period immediately after the history-making GEJE and provides useful information for planning preventive strategies for cardiovascular diseases after great earthquakes in the future. Our results showing the non-increased RRs of OHCA with cardiac origin in the second and third years after the GEJE were similar to those in the CHART-2 registry, which reported no significant long-term prognostic effect after the earthquake among cardiovascular patients in disaster areas.[7] On the other hand, another study reported the mortality risk of acute myocardial infarction increased during the long-term period after the Niigata-Chuetsu earthquake[2] so the risk change of cardiovascular diseases after earthquakes is controversial.

The mechanism of the increase in cardiovascular events in the short term among evacuees can be explained by sympathetic nervous system activation or increased blood pressure and blood viscosity.[1,7] In addition, the preserved foods supplied at the shelter were high in salt and a high salt intake under mental stress increases blood pressure to a greater extent than under normal conditions, thus worsening heart failure.[7,10] However, it might take more time to increase the number of severe cardiovascular events, including cardiac arrest or CVD, in the long term among evacuees. The number of subjects in the population with cardiovascular risk factors such as obesity, diabetes, and hypertension has been increasing after the GEJE,[11] and the long-term evacuation as a consequence of the disaster may have forced changes to people's lifestyles such as diet and physical activity, which may lead to future incidence of lifestyle-related disease including hypertension, diabetes mellitus, and dyslipidemia.[11] In the elderly population, considering that aging increases human sympathetic nervous activity at rest and is the greatest risk factor for thrombosis,[12,13] it is plausible that the intense stress of an earthquake and the changes in lifestyle after the earthquake can trigger cardiovascular events in the high-risk elderly and result in increases in the number of cardiac arrests.[13] Thus, further long-term monitoring in disaster areas is needed.

Study Limitations

The Utstein-style registry does not have information about risk factors for OHCA occurrence such as past medical history/socioeconomic factors. Second, the risk of cardiovascular diseases after the GEJE might differ between inland and coastal areas,[14] but we did not have informa-

Table. Changes in the Incidence of OHCA of Presumed Cardiac Origin Before and After the GEJE

	Year after GEJE			
	Pre year	1st year	2nd year	3rd year
	March 11, 2010–March 10, 2011	March 11, 2011–March 10, 2012	March 11, 2012–March 10, 2013	March 11, 2013–March 10, 2014
All men				
Population, n	2,226,000	2,204,000	2,201,000	2,202,000
OHCA of presumed cardiac origin, n	2,262	2,403	2,185	2,297
Incidence of OHCA of presumed cardiac origin per 100,000 population	101.6	109.0	99.3	104.3
Adjusted RR*		1.07	0.97	0.99
95% CI	Ref.	(1.01–1.13)	(0.91–1.03)	(0.93–1.05)
P value		0.027	0.273	0.786
Men, age 20–74 years				
Population, n	1,955,000	1,930,000	1,920,000	1,913,000
OHCA of presumed cardiac origin, n	967	934	873	911
Incidence of OHCA of presumed cardiac origin per 100,000 population	49.5	48.4	45.5	47.6
Adjusted RR*		0.98	0.91	0.93
95% CI	Ref.	(0.89–1.07)	(0.83–0.99)	(0.84–1.02)
P value		0.615	0.037	0.114
Men, age ≥75 years				
Population, n	271,000	274,000	281,000	289,000
OHCA of presumed cardiac origin, n	1,295	1,469	1,312	1,386
Incidence of OHCA of presumed cardiac origin per 100,000 population	477.9	536.1	466.9	479.6
Adjusted RR*		1.13	1.01	1.04
95% CI	Ref.	(1.05–1.22)	(0.94–1.10)	(0.96–1.13)
P value		0.001	0.723	0.297
All women				
Population, n	2,441,000	2,413,000	2,397,000	2,391,000
OHCA of presumed cardiac origin, n	1,734	1,928	1,684	1,769
Incidence of OHCA of presumed cardiac origin per 100,000 population	71.0	79.9	70.3	74.0
Adjusted RR*		1.12	0.97	1.02
95% CI	Ref.	(1.05–1.19)	(0.90–1.04)	(0.96–1.10)
P value		0.001	0.341	0.497
Women, age 20–74 years				
Population, n	1,979,000	1,943,000	1,919,000	1,904,000
OHCA of presumed cardiac origin, n	336	339	314	334
Incidence of OHCA of presumed cardiac origin per 100,000 population	17.0	17.4	16.4	17.5
Adjusted RR*		1.04	0.91	1.03
95% CI	Ref.	(0.89–1.21)	(0.78–1.07)	(0.87–1.21)
P value		0.627	0.270	0.726
Women, age ≥75 years				
Population, n	462,000	470,000	478,000	487,000
OHCA of presumed cardiac origin, n	1,398	1,589	1,370	1,435
Incidence of OHCA of presumed cardiac origin per 100,000 population	302.6	338.1	286.6	294.7
Adjusted RR*		1.14	0.98	1.03
95% CI	Ref.	(1.06–1.22)	(0.91–1.06)	(0.95–1.11)
P value		<0.001	0.595	0.505

*Adjusted for prefecture and age. CI, confidence interval; GEJE, Great East Japan Earthquake; OHCA, out-of-hospital cardiac arrest; RR, relative risk.

tion on the location of the cardiac arrest. Third, the category of presumed cardiac arrest is a diagnosis by exclusion (i.e., the diagnosis was made when there was no evidence of a non-cardiac cause), in accordance with Utstein-style international guidelines for cardiac arrest data reporting.[15] Fourth, we estimated the population from the residence certificates. However, the actual population in disaster areas would change after the earthquake because most evacuees outside the prefectures did not change the registry of their residence certificates. This observation would not,

therefore, underestimate the increase in OHCA with cardiac origin after the earthquake.

Conclusions

The GEJE significantly increased the occurrence of OHCA with cardiac origin in the disaster areas in the first year after the earthquake, but the risk of occurrence of OHCA with cardiac origin did not continue in the second or third year after the quake.

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