Cardiovascular Effects of an Earthquake
Direct Evidence by Ambulatory Blood Pressure Monitoring

Gianfranco Parati, Roberto Antonicelli, Francesco Guazzarotti, Enrico Paciaroni, Giuseppe Mancia

Abstract—The increased cardiovascular mortality during an earthquake has been related, among other factors, to a sympathetically mediated increase in heart rate and blood pressure. However, this is supported only by indirect evidence collected after an earthquake, whereas for obvious technical difficulties, no data are available on the acute blood pressure and heart rate effects during an earthquake. In a patient undergoing 24-hour ambulatory blood pressure monitoring (Spacelabs 90207), we had the opportunity to directly record the acute blood pressure and heart rate changes induced by an earthquake (magnitude 4.7 according to the Richter scale) that struck central Italy in March 1998. Systolic blood pressure rose to 150 mm Hg, diastolic blood pressure rose to 122 mm Hg, and heart rate rose to 150 bpm at the time of the strongest tremor. Prequake blood pressure levels were restored only 1 hour later, but blood pressure remained characterized by a pronounced variability throughout the following 6 hours. Thus, a sympathetically mediated combined increase in blood pressure and heart rate may represent an important pathophysiological mechanism responsible for the increased frequency of cardiovascular events during an earthquake. The associated increase in blood pressure variability might further contribute to the increase in cardiovascular risk typical of this condition. Our case report further supports the usefulness of ambulatory blood pressure monitoring to assess the blood pressure and heart rate effects of sudden daily life events, the actual cardiovascular impact of which can hardly be quantified through traditional measurements. (Hypertension. 2001;38:1093-1095.)

Key Words: earthquake ■ blood pressure ■ blood pressure monitoring, ambulatory ■ mortality ■ stress

An earthquake is one of the most frightening natural events that might hit a human community. When such a terrifying natural disaster occurs, the high death toll that is usually paid comes not only from injuries related to the destruction of buildings or road accidents but also from sudden death resulting from cardiovascular problems, as clearly shown during the earthquakes striking Athens in 1981, Newcastle in 1991, and California in 1989 and 1994.1–5 The increased rate of cardiovascular mortality during an earthquake has been ascribed to the impact of a major emotional stress on the heart, mediated through an increase in cardiac sympathetic activity.4,5 However, in these circumstances, a nonnegligible role may also be played by a rise in blood pressure. Previously published studies addressing this issue have indeed provided some indirect evidence, usually collected after the event, that earthquake-associated stress is responsible for a subsequent increase in blood pressure among disaster victims. This was shown to occur for the earthquakes hitting Texas City in 1948,6 Wyoming Valley in 1980,7 or, more recently, the Hanshin-Awaji district in Japan in January 1995.8 In the last case, a significant blood pressure rise in a number of subjects living in the Hjogo prefecture was reported after the disaster. The blood pressure values recorded after the quake, compared with values before the quake, peaked in the first week after the seismic episode and, on average, returned to baseline after a time interval ranging from 4 to 6 weeks to 6 months.9,10 According to Kario et al,11 the blood pressure increase induced by the earthquake was associated with potentiation of other cardiovascular risk factors (including increases in hematocrit levels, plasma fibrinogen, plasma von Willebrand factor, and plasma D-dimer concentration) possibly involved in triggering the more frequent cardiovascular events occurring after such an incident.

However, all evidence of the effects of an earthquake on blood pressure reported so far is based only on the comparison between clinic, home, or ambulatory blood pressure measurements obtained before and those obtained after a quake; thus, these data can only suggest a possible mechanism for the cardiovascular events occurring days or weeks after a quake. On the contrary, no data are available on the acute cardiovascular effects of a quake, as directly recorded when the earth is actually trembling. This lack of data is due to the obvious technical difficulties in having blood pressure...
measured during a fast and threatening event such as an earthquake. We had the unique opportunity to record the acute effects of this stressful event on the blood pressure and heart rate of a patient undergoing 24-hour ambulatory blood pressure monitoring during the earthquake, which struck a large region of central Italy during March 1998. These data are reported briefly below.

Methods
A white female subject (age, 34 years) was having her ambulatory blood pressure monitored at the time of a quake, which struck the Marche and Umbria regions (Central Italy) on March 26, 1998. She had been referred to the Hypertension Center of the Italian National Research Center on Aging (INRCA) Institute of Ancona because of the recent occasional detection of high clinic blood pressure values. The ambulatory blood pressure recording started at 11:30 AM on March 26, 1998, and was performed by an oscillometric Spacelabs 90207 monitoring device; automatic blood pressure readings had been programmed at 15-minute intervals. The subject was a non-smoker and was not on any drug treatment at the time of the recording. The strongest earthquake occurred at 5:26 PM of the same day and lasted 48 seconds; its intensity, which was carefully documented by the seismographic recording that we have been able to obtain, reached the 7th degree on the Mercalli scale (equivalent to magnitude 4.7 on the Richter scale). Quakes of lesser intensity were perceived at an earlier time, starting at 2:10 PM according to press reports, although for these milder events, we have not been able to obtain the corresponding seismographic documentation of these events is unfortunately not available). The bottom panel shows the original seismographic recording of the strongest earthquake, which struck Central Italy on March 26, 1998 at 17:26 (5:26 PM; duration, 48 seconds).

Results
As shown in the Figure, blood pressure and heart rate values before the earthquake were 130/85 mm Hg and 83 bpm, respectively; some higher blood pressure values were recorded when the ambulatory blood pressure monitor was put on the patient, probably because of the well-known alerting reaction to the hospital environment. The earth started trembling in the early afternoon, and these initial quakes, even if they were only of mild-to-moderate intensity, were enough to induce noticeable blood pressure (mainly diastolic) and heart rate changes, which were most evident at 2:10 to 2:15 PM, as shown in the Figure. The strongest earthquake shock (at 15:26 PM) induced a systolic blood pressure rise up to 150 mm Hg and a much higher rise in diastolic blood pressure, up to 122 mm Hg. The blood pressure increase was accompanied by a pronounced tachycardia (150 bpm). The pressor effect was still evident after 30 minutes (although less pronounced than at the time of the quake), amounting to 16% and 22% compared with prequake values for systolic and diastolic blood pressure, respectively. On the other hand, the heart rate returned to baseline in a much faster fashion. Prequake blood pressure levels were restored only 1 hour after the earthquake, but blood pressure remained characterized by a pronounced variability throughout the following 6 hours.

Discussion
The present report offers the first direct evidence, obtained in real time, of the acute effects of an earthquake shock on blood pressure...
by guest on April 6, 2017 http://hyper.ahajournals.org/ Downloaded from during an earthquake, our case report emphasizes the importance of ambulatory blood pressure monitoring, which has the potential ability to provide information, even if occasionally of anecdotal nature, on the blood pressure and heart rate effects of sudden and, at times, even threatening events that might occur in daily life.

References

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