Relationship Between the Occurrence of Spontaneous Intracerebral Hemorrhage and Holidays and Traditionally Unlucky Days in Fukuyama City, Hiroshima Prefecture, Japan

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To investigate whether calendrical information influences the occurrence of spontaneous intracerebral hemorrhage, we statistically compared the incidence of intracerebral hemorrhage for inpatients at Teraoka Memorial Hospital (164 patients), against various calendrical factors such as the day of the week, national holidays, and RokuYo (a recurring six-day series of lucky and unlucky days in the Japanese traditional calendar) over the period from January 1, 2001 to December 31, 2003. On Japanese national holidays the relative risk of intracerebral hemorrhage is significantly higher than on other days, certainly due to much more alcohol consumption on holidays. During RokuYo, the relative risk of intracerebral hemorrhage is extremely low on the traditionally unlucky days of ButsuMetsu and TomoBiki, as many Japanese people restrain their activities on these days. Certain days of the year and certain times of the Japanese supplemental calendars correlate significantly with the incidence of intracerebral hemorrhage. **Key Words:** Intracerebral hemorrhage—calendar—holiday—air temperature.

Calendrical information, including the timing of annual events and holidays, is used by many people to plan events, travel, and work and significantly influences our social, economic, and daily lives. This is especially true in Japan, where the Gregorian calendar is supplemented by information drawn from other detailed calendars, including the Japanese and Chinese lunar calendars. As part of a policy of Europeanization at the start of the Meiji Era in 1868, Japan replaced the lunar calendar with the Gregorian calendar.

Many Japanese believe in the concept of RokuYo, a recurring 6-day series of lucky and unlucky days that was first practiced during the TenPou Era (1830–1844 AD) in the Edo Period. Many still avoid scheduling events such as weddings and funerals on unlucky RokuYo days.

The significant influence of calendrical information on human activities in Japan extends to the development of disease. Many Japanese link disease occurrence with to various calendrical factors, including day of the week, national holidays, stage of the tide, RokuYo, and phase of the moon.[1-11] In the present study, we investigate whether such calendrical information influences the occurrence of intracerebral hemorrhage (ICH) in the population of a mid-sized Japanese city with a stable population, many of whom commonly consult calendrical information in their daily lives.

Subjects and Methods

The study subjects consisted of all patients with ICH admitted during the acute stage (within 3 days) and treated at Teraoka Memorial Hospital, Shin-ichi Town, Fukuyama City, Hiroshima Prefecture, Japan between January 1, 2001 and December 31, 2003. On admission, computed tomography (CT) scans were performed on those patients with acute onset of neurologic

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defects with suspected ICH. If ICH due to arteriovenous malformation (AVM), Moyamoya disease, or cerebral aneurysm was suspected based on the initial CT scan or patient history, then magnetic resonance imaging (MRI) and angiography, CT angiography, or digital subtraction angiography studies were performed. Patients with ICH with AVM, cerebral aneurysm, brain tumor, Moyamoya disease, or head injury were excluded from the study. Data on the time of onset of ICH were recorded for all patients. For those patients who awoke with a deficit in the morning, the onset time was considered as 0600.

Shin-ichi Town is situated at the west edge of the Fukuyama Basin, surrounded by mountains. Although there are 2 other hospitals in this area, they do not have neurosurgeons or neurophysicians on staff, and all patients with ICH at these hospitals are to be transferred to Teraoka Memorial Hospital at the acute stage. Therefore, we can consider that almost all patients with ICH and certain neurologic deficits living in the west part of the Fukuyama Basin area would have presented at Teraoka Memorial Hospital.

Daily mean tidal levels were measured at Kainan Port, the nearest observation platform to Shin-ichi Town for which the Japanese Meteorological Agency records tidal forces. The Japanese Meteorological Agency collects meteorological data for all major Japanese cities, including the distribution of atmospheric pressure, maximum and minimum air temperature, daily average humidity, and precipitation.

We statistically compared the relative risk (RR) of all ICH cases against various calendrical factors over the study period, including day of the week, national holidays, stage of the tide, RokuYo, and phase of the moon. According to RokuYo, each day is classified as 1 of 6 days in a recurring 6-day calendrical series consisting of SenSho, TomoBiki, SenBu, ButsuMetsu, TaiAn, and ShakKo. ButsuMetsu is believed to be an unlucky day, on which weddings and special events are avoided, and many crematories in Japan are closed on TomoBiki. Conversely, the other days of RokuYo, especially TaiAn, are believed to be lucky days, and thus events or ceremonies are generally scheduled for these days.

For a statistical analysis of the data, we used unpaired *t* tests, Pearson's linear regression analysis, Fisher's exact test, and multivariate logistic regression analysis using GraphPad Instat 3 software (GraphPad Software Inc, San Diego, CA) and StatView 4.11 software (SAS Institute, Cary, NC). We calculated the RRs of ICH, with 95% confidence intervals (CIs) determined using the Katz approximation, from contingency tables for each calendrical factor considered (day of the week, holiday, day of RokuYo, and month of the year). All *P* values are 2-sided. To investigate the association between various calendrical factors and the incidence of ICH, we used multiple logistic regression techniques, taking the incidence of ICH as the dependent variable and the calendrical factors

Table 1. *Comparison of monthly averaged meteorological data and RR of ICH*

Month	Case/day number	RR	95% CI (Fisher's exact test *P* value)	Daily mean tidal level (mm) (SD)	Mean maximum/minimum temperature (°C) (SD)	Mean air pressure (hPa) (SD)	Humidity (%) (SD)	Precipitation (mm) (SD)
1	20/93	1.49	0.9790–2.258 (.0942)	−78.5 (125.2)	8.6/1.5 (3.2/2.6)	1019.0 (6.3)	69.9 (9.0)	2.0 (4.5)
2	10/84	0.78	0.4305–1.430 (.5244)	−112.6 (97.0)	10.4/2.8 (2.4/2.6)	1021.2 (5.2)	69.2 (9.1)	2.0 (4.4)
3	16/93	1.17	0.7313–1.874 (.5425)	−91.2 (106.6)	14.0/5.2 (3.8/3.2)	1017.3 (7.3)	63.6 (11.7)	3.4 (8.3)
4	15/90	1.13	0.6949–1.836 (.6432)	−50.4 (121.1)	19.6/10.8 (2.7/3.6)	1016.3 (4.8)	63.5 (15.1)	4.0 (8.7)
5	20/93	1.47	0.9674–2.234 (.0961)	57.8 (126.2)	23.9/15.6 (2.6/2.5)	1012.5 (5.8)	66.8 (12.9)	6.3 (15.4)
6	11/90	0.81	0.4547–1.431 (.5385)	160.4 (137.3)	26.6/19.8 (2.6/2.2)	1008.9 (3.7)	72.0 (12.5)	7.7 (17.6)
7	13/93	0.93	0.5511–1.577 (0.88)	162.8 (181.3)	30.3/24.0 (3.0/2.2)	1008.7 (3.7)	75.3 (9.4)	8.3 (16.0)
8	8/93	0.56	0.2852–1.107 (0.0924)	226.4 (169.0)	31.7/24.8 (2.5/2.0)	1009.6 (4.8)	70.2 (8.2)	3.5 (8.3)
9	9/90	0.65	0.3445–1.232 (0.2164)	291.8 (63.9)	28.7/20.7 (2.9/3.1)	1013.2 (4.3)	67.6 (9.9)	4.5 (14.7)
10	9/93	0.64	0.3362–1.204 (0.1704)	243.6 (124.7)	22.7/13.9 (3.2/3.1)	1017.7 (4.6)	67.3 (8.2)	3.5 (11.9)
11	15/90	1.12	0.6863–1.815 (0.6458)	103.6 (142.1)	16.3/8.1 (3.1/3.7)	1020.4 (5.5)	70.5 (10.0)	2.6 (6.2)
12	18/93	1.29	0.8282–2.010 (0.293)	−2.5 (135.0)	11.3/3.7 (2.8/2.7)	1021.9 (5.4)	71.9 (8.5)	1.7 (5.0)
11∼1	53/276	1.392	1.033–1.876 (0.0332)	5.1 (152.8)	12.0/4.4 (4.4/4.1)	1020.4 (5.9)	70.8 (9.2)	2.1 (5.3)
6∼10	50/459	0.62	0.4524–0.8417 (0.002)	216.9 (149.7)	28.0/20.7 (4.3/4.7)	1011.6 (5.5)	70.5 (10.1)	5.5 (14.1)
Distribution				−386∼550	0.9∼36.9/−3.7∼28.5	988∼1037	35.0∼97.0	0∼128.5
Average or sum	164/1095			78.0 (188.4)	20.4/12.6 (8.3/8.6)	1015.5 (6.9)	69.0 (11.0)	4.1 (11.3)

Table 2. *Comparison of the RR of ICH with days of the week and Japanese national holidays*

Day of the week	Case/day number	RR	95% CI	Fisher's exact test *P* value
Monday	25/157	1.09	0.7344–1.606	.7162
Tuesday	23/157	0.97	0.6455–1.459	1
Wednesday	22/157	0.94	0.6215–1.429	.9033
Thursday	23/156	0.98	0.6553–1.480	1
Friday	23/156	0.98	0.6553–1.480	1
Saturday	31/156	1.36	0.9526–1.933	.1192
Sunday	17/156	0.70	0.4350–1.121	.146
Holiday	21/69	2.15	1.458–3.180	.0008
Total	164/1095			

listed earlier, along with maximum air temperature (in °C) as the independent variables.

Results

The study population comprised 164 patients with ICH. The background population of the area serviced by Teraoka Memorial Hospital, as calculated from the 2000 national census, is approximately 72,000, and the annual population-based incidence of ICH is 76/100,000. The study population included 83 men and 81 women, ranging in age from 42 to 92 years (average age, 70.4 years; standard deviation, ±11.3). During the study period, there were no infant patients. The past histories of 159 of the patients with ICH were known from hospital records or information supplied from patients or relatives. Although hypertension was medicated until hospital admission in 51 patients (32.1%), 93 patients (58.5%) still required antihypertensive agents at approximately 1 month from the onset of ICH. In the remaining 42 patients (26.4% of all patients), either hypertension was latent or no proper treatment for hypertension was provided. Generally, medical compliance is considered worse on holidays than on workdays; however, we were unable to assess this trend in the present study, due to lack of relevant data. Diabetes mellitus affected 19 patients (11.9%); liver dysfunction, 15 patients (9.4%). A total of 138 patients with ICH (86.8%) had a background disease. Stroke (here including 23 cases with cerebral infarction [CI], 13 with ICH, and 2 with subarachnoid hemorrhage [SAH]; collectively 23.9% of the total), is the most significant background disease considered to induce ICH, followed by hypertension.

Detailed medical information at the onset of ICH for 147 of the patients were provided by the patients themselves or by relatives or other concerned persons. A total of 84 patients (57.1%) became sick at home, and 63 (42.9%) were stricken outside the home. Ten cases each of ICH (6.8%) occurred while the patient was in bed, on the toilet, in the bath, at work, and in the hospital or a home for the aged; 6 cases each (4.1%) occurred while the patient was in the kitchen and drinking alcohol; and 2 cases each (1.4%) occurred while the patient was attending a wedding party and engaged in a sporting activity.

Unpaired *t* test results indicate a statistically significant difference between days with and without occurrence of ICH in terms of maximum air temperature ($P = .0120$). Pearson's linear regression analysis reveals that the RR of ICH each month was inversely proportional to the mean maximum air temperature in that month ($r^2 = .3406$; $P = .0464$).

In terms of monthly trends, the RR was high from November to January and low from June to October ($P = .0332$, .0020; Table 1). In terms of day of the week, the RR of ICH was relatively low on Sunday and high on Saturday. Japan has 23 national holidays each year, and the RR of ICH is generally high on these days ($P = .0008$; Table 2). Over the study period, national holidays fell more frequently on Mondays than on any other day of the week (37.7%). In terms of RokuYo, the unlucky days of ButsuMetsu and TomoBiki exhibited an extremely low RR for ICH compared with other RokuYo days ($P = .0001$; Table 3).

An analysis using the forward stepwise method of multivariate logistic regression indicates that the incidence of ICH is significantly influenced by maximum air temperature and certain times on the Japanese calendar, including national holidays and the lucky days of RokuYo ($P < .0001$; Table 4). RokuYo is closely connected with the behavioral patterns of Japanese people; many restrain their activities on ButsuMetsu and TomoBiki days. National holidays are connected with behavioral factors as well, in terms of increased alcohol consumption on these days. Maximum air temperature represents meteorological influences on the body.

For all patients with CI (384 patients), meningitis (29 patients), and severe head trauma (ie, acute subdural hematoma, acute epidural hematoma, brain contusion, and cranial fracture; 150 patients) admitted to Teraoka Memorial Hospital during the 3 years of the study period, statistical analyses were conducted to determine the calendrical factors that most influenced the onset days of these diseases. CI occurred most commonly between May

Table 3. *Comparison of RokuYo and RR of ICH*

RokuYo	Case/day number	RR	95% CI	Fisher's exact test *P* value
SyakKo	33/184	1.299	0.854–1.975	.2155
SenSyo	32/184	1.24	0.813–1.893	.3106
TomoBiki	14/182	0.433	0.244–0.768	.0028
SenBu	32/182	1.25	0.819–1.908	.3083
ButsuMetsu	19/182	0.617	0.372–1.025	.0687
TaiAn	34/181	1.38	0.911–2.092	.1396
ButsuMetsu and TomoBiki	33/364	0.463	0.309–0.694	.0001
SyakKo, SenSyo, SenBu, and TaiAn	131/731	2.159	1.441–3.236	.0001
Total	164/1095			

and August (Fisher's exact test; RR = 1.248; 95% CI= 1.058–1.472; $P = .0102$) and on Sundays (RR = 1.331; 95% CI = 1.091–1.625; $P = .0101$), and meningitis occurred most commonly between May and August (RR = 2.415; 95% CI = 1.174–4.967; $P = .0169$). Severe head trauma was rarely reported on national holidays (RR = 0.1813; 95% CI = 0.04394–0.7484; $P = .0053$) but was more common on Mondays (RR = 1.684; 95% CI = 1.164–2.436; $P = .0099$).

Differences in the variables influencing the occurrence of ICH compared with the other diseases analyzed in this study are considered related to differences in the activities and environments that predispose persons to onset of each disease.

Discussion

Monthly Differences in the RR of ICH

Monthly RR of ICH were high between November and January and in May and were low between June and October (see Table 1). This pattern can be explained by the lower mean air temperatures in November–January and higher mean air temperatures in June–October (although air temperature cannot explain the high incidence during May).[12,13] Japan has a 3-day national holiday in May; therefore, the higher incidence of ICH on national holidays results in a higher incidence for May. Although previous studies have reported a high prevalence of ICH in February,[9] we found no such tendency in the present study.

Table 4. *Multivariate logistic regression analysis of factors related to maximum air temperature and various calendrical data*

	Adjusted odds ratio	95% CI	*P* value
Maximum air temperature (°C)	(0.976)	(0.957–0.996)	0.0199
Days except for Japanese evade days (RokuYo)	2.182	1.452–3.280	0.0002
National holidays	2.573	1.487–4.453	0.0007

Relationship Among Japanese National Holidays, Day of the Week, and ICH

The RR of ICH is high on Japanese national holidays but relatively low on Sundays (see Table 2). On Sundays, people tend to rest, recover from exhaustion, and refresh their spirits. The high RR of ICH on national holidays likely is related to the significantly greater alcohol consumption on holidays compared with workdays. Records of the Fukuyama Fire Department show that the highest number of transfers of patients with acute alcoholism to hospitals in Fukuyama by ambulance between January 1, 2004 and December 31, 2005 (a total of 568 cases in 731 days) occurred on national holidays (65 cases in 43 days; Fisher's exact test; RR = 1.425; 95% CI = 1.206–1.684; $P = .0004$), followed by Saturdays (110 cases in 99 days; RR = 1.253; 95% CI = 1.082–1.450; $P = .0049$). The extremely high RR of ICH on national holidays is considered related to increased alcohol consumption on this day; in our analysis, the occurrence of ICH when drinking was high on holidays (Fisher's exact test; $P = .0231$).

Lucky and Unlucky Days

The RR of ICH was unexpectedly low on ButsuMetsu and TomoBiki, in contrast to relatively high RR on the days of TaiAn. Of the 622 weddings celebrated at the Fukuyama New Castle Hotel (one of the largest wedding halls in the vicinity of Teraoka Memorial Hospital) between April 1, 2004 and March 31, 2006, only 12 (1.93%) were held on ButsuMetsu. Figures from the Fukuyama Municipal Office show that between October 1 and December 31, 2005, of the 824 public cremations performed in Fukuyama City, only 20 (2.4%) were done on TomoBiki days, but 211 (25.6%) were done on SenBu, the day after TomoBiki. Avoiding scheduling such important life ceremonies on ButsuMetsu and TomoBiki influences the daily activities of Japanese people, in turn resulting in a low RR of ICH on these days. Records from the

Fukuyama Fire Department for 2004–2005 show that the incidence of patients with acute alcoholism (a total of 568 cases in 731 days) was lowest on ButsuMetsu days (79 cases in 120 ButsuMetsu days), followed by TomoBiki days (83 cases per 121 TomoBiki days), with the greatest incidence occurring on TaiAn days (108 cases per 124 TaiAn days). In this study, all occurrences of ICH during events outside the home, including attending wedding parties and playing sports, occurred on days other than ButsuMetsu and TomoBiki (4 cases).

Based on our findings, the following preventive countermeasures should be considered:

1. Inform the Japanese people that on the days of RokuYo, ButsuMetsu, and TomoBiki, when people generally avoid scheduling activities, the RR of ICH is extremely low. This knowledge may help free some people from their superstitions regarding these days.

2. Warn people to use restraint when engaging in such activities as drinking and physical activity, especially on national holidays.

Given that our analyses were performed in a local area of Japan, and considering the wide variety of calendrical patterns used throughout the world, extrapolating our findings in their current form to other areas of the world is problematic. Nonetheless, this study provides an interesting example of the way in which climate and cultural traditions, in intricate combinations, influence the susceptibility to seasonal disease.

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