Biometeorologic Studies on Cerebrovascular Diseases

II. Seasonal Observation on Effects of Meteorologic Factors on the Death from Cerebrovascular Accident

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In order to clarify the seasonal difference in meteorologic effects on the deaths from cerebrovascular accidents and to evaluate ecological factors closely associated with it, the present study was accomplished on 1,075 deaths from cerebral hemorrhage and 527 from cerebral infarction which occurred in Nagoya, 1965. Low air temperature, low temperature-humidity index and low MISSENARD's effective temperature in spring; high air temperature and its increase, low relative humidity and high temperature-humidity index in summer; increasing atmospheric pressure in autumn; decreasing atmospheric pressure in all seasons and many other meteorologic factors were revealed as the definitely contributing factors to the deaths. The effects of the variations of air temperature gradient and of relative humidity gradient on the deaths were also recognized. The importance of the indoor temperature especially in winter and of ecological factors such as clothings and dwelling conditions were emphasized. And it was concluded that the control of meteorological factors in every season would furnish an effective preventive measure against cerebrovascular accidents.

THE AUTHOR has been studying the possible relationships of meteorologic factors with cerebrovascular diseases and the detailed analyses of the deaths as to the values, the gradients and the variations of gradient of some meteorologic factors were reported in the first paper,⁴ concluding that the meteorologic factors, especially low and high air temperature, decreasing atmospheric pressure and increasing relative humidity, apparently affected the deaths from cerebrovascular accidents. The excess deaths in the cold season and the fewer in the hot season were also clearly recognized. This finding indicates not only the importance of meteorologic factors, but also of the seasonal difference in their effects on the human body, because the seasonal variations of the other environmental factors such as nutritional factor are not to be conjectured and a man

maintains his health adapting to each season by various means such as changes of clothings, dwelling conditions and so on.

It must be noted that the meteorologic factors are not independent each other. For instance, the increasing phase of air temperature corresponds to the decreasing phase of relative humidity and vice versa. Therefore, the studies on the relationship between the deaths from cerebrovascular accidents and meteorologic factors should be undertaken in various combinations of meteorologic factors or their changes.

This is the second report of a series of author's studies and aims:

1. To clarify whether the effects of meteorologic factors on the deaths from cerebrovascular diseases are different by air temperature range or not.

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TABLE I RELATIVE FREQUENCIES (REFER TO TEXT) IN PERCENTAGE OF THE DEATHS FROM CEREBRAL HEMORRHAGE AND FROM CEREBRAL INFARCTION ACCORDING TO AIR TEMPERATURE AT THE TIME OF EACH DEATH, BY SEASONS

Air temperature (°C)	-6°~	-2°~	2°~	6°~	10°~	14°~	18°~	22°~	26°~	30°~	34°~	Total
WINTER												
Number of sampled	13	117	154	120	26	2						432
Cerebral hemorrhage	-27.5 (7)	-1.1 (86)	-1.3 (113)	+7.7 (96)	-12.0 (17)	+34.6 (2)						(321)
Cerebral infarction	+5.2 (5)	-8.9 (39)	+1.2 (57)	+0.3 (44)	+36.7 (13)	— (0)						(158)
SPRING												
Number of sampled	1	44	54	88	91	77	51	27	8			441
Cerebral hemorrhage*	+210.6 (2)	+51.8 (43)	+15.0 (40)	-1.2 (56)	-19.8 (47)	-5.2 (47)	-14.8 (28)	-31.0 (12)	+74.7 (9)			(284)
Cerebral infarction	+208.4 (1)	+26.2 (18)	+8.5 (19)	-5.4 (27)	+1.7 (30)	-23.9 (19)	+2.8 (17)	-20.1 (7)	+54.2 (4)	— (1)		(143)
SUMMER												
Number of sampled						16	93	173	99	52	6	439
Cerebral hemorrhage*					— (2)	+47.7 (12)	-13.2 (41)	-18.1 (72)	+13.3 (57)	+24.9 (33)	+96.9 (6)	(223)
Cerebral infarction*						-30.8 (3)	-40.5 (15)	+10.9 (52)	+15.5 (31)	+13.5 (16)	+23.0 (2)	(119)
AUTUMN												
Number of sampled			13	43	94	96	95	70	22	3		436
Cerebral hemorrhage			-18.5 (6)	-5.6 (23)	-11.7 (47)	+17.7 (64)	+9.6 (59)	-9.2 (36)	-11.7 (11)	-41.2 (1)		(247)
Cerebral infarction			+88.1 (6)	-33.7 (7)	-13.3 (20)	+14.6 (27)	+24.4 (29)	-24.3 (13)	-7.4 (5)	— (0)		(107)

(): observed number of death

* $P < 0.05$

Plus percentage means the excess deaths and absolute value shows the extent of the excess or fewer deaths.

Fig.1. Trends of relative frequencies of the deaths from cerebral hemorrhage and from cerebral infarction according to relative humidity at the time of each death by seasons were illustrated in semi-logarithmic scale, smoothing by two point moving average method.

* $P < 0.05$ ** $P < 0.01$

2. To prove the essential role of ecological factors through the further analyses of relationships between the deaths and meteorologic factors by seasons.

3. To indicate the possibility of the prevention of the deaths from cerebrovascular diseases by the controls of some meteorologic factors.

MATERIALS AND METHODS

The present study was accomplished on 1,075 deaths from cerebral hemorrhage and 527 deaths from cerebral infarction in Nagoya, 1965. The detailed meteorologic data such as the values, the gradients and the variations of gradient at the time of each death were obtained from thermograms, hygrograms and barograms recorded at Nagoya Weather Bureau in the year. The variation of gradient was measured as the curvature of the curve on each record. To evaluate the combined meteorologic effects, temperature-humidity index and MISSENARD's effective temperature at the time of each death were calculated from air temperature, relative humidity and wind velocity measured on anemograms. In order to get the expected number of death based on the null hypo-

Fig.2. Trends of relative frequencies of the deaths from cerebral hemorrhage according to relative humidity gradient at the time of each death by air temperature ranges were illustrated in semi-logarithmic scale, smoothing by three point moving average method.

*** $P < 0.001$

TABLE II RELATIVE FREQUENCIES IN PERCENTAGE OF THE DEATHS FROM CEREBRAL AND FROM CEREBRAL INFARCTION ACCORDING TO TEMPERATURE-AT THE TIME OF EACH DEATH, BY SEASONS

T - H Index		25~	30~	35~	40~	45~	50~	55~	60~	65~
WINTER	Number of sampled	10	58	90	115	105	46	8	0	
	Cerebral hemorrhage	-46.2 (4)	-7.2 (40)	+10.7 (74)	-4.0 (82)	+7.7 (84)	-9.3 (31)	-32.7 (4)	— (2)	
	Cerebral infarction	-45.3 (2)	+8.4 (23)	+9.4 (36)	-12.0 (37)	-3.7 (37)	+24.8 (21)	-65.8 (1)	— (1)	
SPRING	Number of sampled		9	39	39	75	77	71	62	46
	Cerebral hemorrhage***		+55.3 (9)	+51.3 (38)	+43.3 (36)	-13.0 (42)	-9.3 (45)	-12.5 (40)	+2.7 (41)	-46.0 (16)
	Cerebral infarction***		+139.0 (7)	+10.7 (14)	+18.6 (15)	-17.8 (20)	+4.1 (26)	-13.1 (20)	+9.4 (22)	-26.3 (11)
SUMMER	Number of sampled							4	26	70
	Cerebral hemorrhage							+146.1 (5)	+13.6 (15)	+12.5 (40)
	Cerebral infarction*							-7.8 (1)	-71.6 (2)	-21.0 (15)
AUTUMN	Number of sampled			5	11	37	68	69	74	100
	Cerebral hemorrhage			+5.9 (3)	+12.3 (7)	-18.9 (17)	-14.3 (33)	+35.6 (53)	+0.2 (42)	-13.5 (49)
	Cerebral infarction			-18.5 (1)	+122.3 (6)	-22.9 (7)	-16.1 (14)	+24.0 (21)	+10.1 (20)	+1.9 (25)

(): observed number of death

* P < 0.05 *** P < 0.001

thesis, each distribution of meteorologic factors or their changes by seasons and by air temperature ranges was obtained by measuring or calculating them at 1,748 time points selected at random throughout the year.

The relative frequency of the death was expressed as

$$\left(\frac{\text{observed number of death}}{\text{expected number of death}} - 1 \right) \times 100$$

Two or three point moving average methods were applied for the clearer demonstration of the trends of relative frequencies in figures. Seasons are as follows; winter (December, January and February), spring (March, April and May), summer (June, July and August) and autumn (September, October and November) and air temperature range was divided into three; low range (below 10°C), moderate range (between 10°C and 25°C) and high range (25°C or above) for further analyses.

RESULTS

I. The death and meteorologic factors, by seasons

Air temperature (Table I)

In spring the excess deaths from cerebral hemorrhage were found in the air temperature below 6°C and the fewer between 6°C and 26°C. The deaths from cerebral infarction tended to be excess in the temperature below 6°C in spring. These findings were not recognized in autumn. In summer the excess deaths from cerebral hemorrhage or infarction were noted in the temperature 26°C or above. It is of interest to note no excess death from cerebral hemorrhage or infarction at low temperature in winter.

Relative humidity (Fig. 1)

In spite of no significant effect of relative humidity on the deaths throughout a year as described in the previous paper,⁴ some interesting findings were revealed by seasons. The excess

HEMORRHAGE
HUMIDITY INDEX

70~	75~	80~	85~	Total
				432
				(321)
				(158)
18	5			441
+20.8	-6.8			(284)
(14)	(3)			
+37.1	—			(143)
(8)	(0)			
154	131	51	3	439
-25.9	+2.2	+31.2	+96.9	(223)
(58)	(68)	(34)	(3)	
-9.0	+15.5	+51.9	+23.0	(119)
(38)	(41)	(21)	(1)	
52	16	4	0	436
-5.0	+21.4	+32.4	—	(247)
(28)	(11)	(3)	(1)	
-29.5	-23.6	—	—	(107)
(9)	(3)	(0)	(1)	

deaths from cerebral hemorrhage in the humidity less than 70% and from cerebral infarction less than 60% in summer were found. The latter was also observed in autumn. The excess deaths from cerebral infarction remained below significant level in winter.

Atmospheric pressure

The fewer deaths from cerebral hemorrhage or infarction were found in the atmospheric pressure less than 1,005 mb in the first report.⁴ The excess deaths from cerebral hemorrhage were noted in the atmospheric pressure 1,010 mb or more in spring and less than 995 mb in autumn, though they were of little statistical significance.

Temperature-humidity index (Table II)

The excess deaths from cerebral hemorrhage or infarction were found in the temperature-humidity index less than 45 in spring and 75 or more in summer. The fewer deaths from infarction were noted in the index less than 75, but the excess from hemorrhage in the index less than 70 in summer.

Fig. 3. Trends of relative frequencies of the deaths according to atmospheric pressure gradient at the time of each death, by seasons.

* $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$

MISSENARD's effective temperature

No significant relationship between the deaths and MISSENARD's effective temperature was found except the excess deaths from cerebral hemorrhage or infarction in MISSENARD's effective temperature below 0°C in spring. This finding in spring was more remarkable than that in air temperature in the same season.

II. The death and the gradients of meteorologic factors, by seasons and by air temperature ranges

Air temperature gradient (Table III)

In the high air temperature range, 25°C or above, the fewer deaths from cerebral hemorrhage or infarction were noted at decreasing air temperature, 1°C per hour or more, and the excess from hemorrhage were also found at increasing air temperature. In moderate or low air temperature ranges, however, no excess death was recognized at increasing or decreasing air temper-

TABLE III RELATIVE FREQUENCIES IN PERCENTAGE OF THE DEATHS FROM AND FROM CEREBRAL INFARCTION ACCORDING TO AIR TEMPERATURE EACH DEATH, BY AIR TEMPERATURE RANGES

°C Per hour	~2.2	~1.8	~1.4	~1.0	~0.6	~0.2	-0.2< <+0.2	+0.2~
<i>Air temp. <10°C</i>								
<i>Number of sampled</i>	2	10	14	44	122	149	107	59
<i>Cerebral hemorrhage</i>	+105.6 (3)	-17.8 (6)	+17.5 (12)	+24.6 (40)	-18.0 (73)	+8.6 (118)	-5.2 (74)	+13.8 (49)
<i>Cerebral infarction</i>	+190.1 (2)	+16.1 (4)	-37.8 (3)	+25.3 (19)	-14.4 (36)	-0.7 (51)	+0.3 (37)	+22.9 (25)
<i>10°C ≤ Air temp. <25°C</i>								
<i>Number of sampled</i>	9	16	22	68	136	184	139	76
<i>Cerebral hemorrhage</i>	+64.2 (8)	+27.0 (11)	+42.7 (17)	-7.6 (34)	-25.3 (55)	+8.4 (108)	-8.3 (69)	+11.8 (46)
<i>Cerebral infarction</i>	+109.8 (5)	-5.6 (4)	+54.5 (9)	-11.1 (16)	+22.2 (44)	+6.7 (52)	-29.4 (26)	-15.5 (17)
<i>Air temp. ≥ 25°C</i>								
<i>Number of sampled</i>	8	13	15	18	31	35	27	28
<i>Cerebral hemorrhage*</i>	-34.1 (3)	-45.9 (4)	-17.9 (7)	-31.6 (7)	+13.5 (20)	+5.5 (21)	-47.9 (8)	+19.3 (19)
<i>Cerebral infarction**</i>	-60.2 (1)	-75.5 (1)	-36.3 (3)	-11.5 (5)	+13.1 (11)	+9.3 (12)	+65.3 (14)	+2.5 (9)

(): observed number of death

* P < 0.05

** P < 0.01

TABLE IV AVERAGE VALUES OF SOME METEOROLOGIC FACTORS AT NAGOYA WEATHER BUREAU, BY SEASONS (3)

Seasons	Winter	Spring	Summer	Autumn
<i>Air temperature (°C)</i>				
<i>Maximum</i>	9.4	17.4	30.3	22.6
<i>Minimum</i>	0.0	6.2	20.6	11.8
<i>Relative humidity (%)</i>	69.3	63.7	79.4	71.7
<i>Atmospheric pressure (mb)</i>	1010.6	1007.4	1002.6	1008.9
<i>Major wind direction</i>	NW	N,S	SSE	N
<i>Wind velocity (m/sec)</i>	3.7	4.2	3.2	3.2
<i>Earth temperature (°C), 0.5 m under the ground</i>	6.5	13.6	26.6	19.4

Winter: Dec. ~ Feb. Spring: Mar. ~ May Summer: Jun. ~ Aug. Autumn: Sept. ~ Nov.

ature.

Relative humidity gradient (Fig.2)

The excess deaths from cerebral hemorrhage were found at increasing relative humidity, more than 5% per hour, in the low air temperature range. In the high air temperature range the ex-

cess deaths were noted at decreasing humidity, more than 5% per hour, but not at increasing humidity. The deaths from cerebral infarction were not affected by the humidity gradient in any temperature ranges.

Atmospheric pressure gradient (Fig.3)

CEREBRAL HEMORRHAGE
GRADIENT AT THE TIME OF

+0.6~	+1.0~	+1.4~	+1.8~	+2.2~	+2.6~	+3.0~	Total
33	34	28	14	15	8	8	647
+12.2	+0.8	-31.5	+7.7	-17.8	-48.6	+37.1	
(27)	(25)	(14)	(11)	(9)	(3)	(8)	(472)
-38.5	-23.2	+14.0	-17.1	+132.1	-63.7	-27.5	
(7)	(9)	(11)	(4)	(12)	(1)	(2)	(223)
53	45	37	26	15	9	11	846
-16.4	+23.1	+9.8	-21.9	+10.8	+125.8	-49.6	
(24)	(30)	(22)	(11)	(9)	(11)	(3)	(458)
+14.0	-32.9	-18.3	+16.2	+25.9	+67.9	-31.3	
(16)	(8)	(8)	(8)	(5)	(4)	(2)	(224)
28	16	22	6	6	1	1	255
+19.3	+97.8	-36.1	+105.2	+17.2	—	—	
(19)	(18)	(8)	(7)	(4)	(0)	(0)	(145)
-43.1	+79.3	-27.6	+6.3	+59.4	—	—	
(5)	(9)	(5)	(2)	(3)	(0)	(0)	(80)

The excess deaths from cerebral hemorrhage in all seasons and those from infarction in summer were found at decreasing atmospheric pressure. In autumn, however, the excess deaths from hemorrhage and infarction were noted at increasing atmospheric pressure. The fewer deaths from cerebral hemorrhage were observed at increasing pressure, 1 mb per hour or more, in spring and winter, and those from infarction at increasing pressure in summer.

III. The death and the variations of gradient of meteorologic factors, by seasons and by air temperature ranges

Variations of air temperature gradient (Fig.4)

In the low air temperature range, the excess deaths from cerebral hemorrhage or infarction were found with the minus curvature on thermograms, i.e. with the increase of negative or with the decrease of positive gradient, and the fewer with the plus curvature, i.e. with the increase of positive or with the decrease of negative gradient. In the high temperature range, the excess from hemorrhage were noted with the plus curvature and in the moderate temperature range the fewer deaths with the minus curvature were found.

Variations of relative humidity gradient (Fig.5)

The excess deaths from cerebral hemorrhage were found with the plus curvature on hygrograms in winter, spring and summer. With the minus curvature, the excess deaths in summer and the fewer in winter were noted. The deaths from cerebral infarction, however, had no significant relation with the variations of humidity gradient.

Variations of atmospheric pressure gradient

In any seasons no significant relationship of the deaths from hemorrhage or infarction with the variations of pressure gradient was noted.

DISCUSSION

A man has his way of life adapted to the seasons by various means such as changes of clothings or of dwelling conditions and then the actual effects of meteorologic factors or their changes may differ season by season. Therefore the analyses by seasons of their effects on the deaths from cerebrovascular accidents are essential for the evaluation of ecological factors closely associated with seasonal differences in meteorologic effects.

In spring the excess deaths from cerebral

Fig. 4. Trends of relative frequencies of the deaths according to the variation of air temperature gradient at the time of each death, by air temperature ranges.

* $P < 0.05$ ** $P < 0.01$ $P < 0.001$

Plus curvature means the increase of positive gradient or the decrease of negative gradient and minus curvature vice versa.

hemorrhage at low air temperature were found, but not in autumn. This finding may be attributed to the much lower air temperature, the more windy days and the less stored heat on the earth in spring than in autumn, as shown in Table IV. The view is supported by the fact that the excess deaths at low MISSENARD's effective temperature were more remarkably noted than those on considering air temperature alone in spring. The negative finding in winter, no excess death at low air temperature, is of quite interest from biometeorological point of view and may properly suggest the notable difference in air temperature between the outdoors and the indoors and the importance of temperature directly affecting on the human body. Air temperature, especially low air temper-

ature, can be easily controlled by various air conditioners or by clothings. The heating instruments for a room such as gas stoves, oil stoves and electric heaters have been very popular in Nagoya and their popularity^{1,5} are about 50%, 30% and 18% in 1965, respectively. The electric blankets and electric foot-warmers (Anka) come also into wide use in the bed-clothes at night and their popularity^{1,5} are about 40% and 80%, respectively. In winter, therefore, microclimatic analyses are essential for the investigations of the relation between the deaths from cerebrovascular accidents and air temperature. The excess deaths at high air temperature in summer are believed to indicate that high temperature affects substantially on the human body with thin clothing, because the room coolers or other air cooling system in private houses are not prevalent yet in Nagoya.¹ The excess deaths at low relative humidity in summer are quite compatible with the excess deaths at high air temperature on thinking over the inverse relationship between humidity and temperature. INOGAWA and TAGA² found, from a study of vital statistics and daily mean humidity in Tokyo, that the excess deaths from cerebrovascular diseases were remarkably noted in the humidity less than 60% and the fewer in more than 80% throughout a year. The excess deaths at low temperature-humidity index in spring and those at high index in summer were noted in the present study. Low air temperature may be responsible for the finding in spring, because humidity has little effect on the deaths in this season. In summer both high temperature and low humidity are responsible for the excess deaths, as shown in Table I and Figure 1. No excess deaths at low temperature-humidity index in winter may suggest the notable difference in temperature and humidity between the outdoors and the indoors. On considering the effects of meteorologic factors or their combinations such as temperature-humidity index and MISSENARD's effective temperature, their possible effects through psychological responses as well as their direct physiological effects must be kept in mind, for the psychological responses to meteorological conditions will exaggerate the physiological responses.

The excess deaths at increasing air temperature in the high air temperature range indicate that not only high temperature but also its increase contributes to the deaths. This finding is also quite compatible with the excess deaths at decreasing relative humidity in the high temperature range, because the increasing phase of air temper-

Fig.5. Trends of relative frequencies of the deaths from cerebral hemorrhage according to the variation of relative humidity gradient at the time of each death, by seasons.

* $P < 0.05$ *** $P < 0.001$

ature corresponds to the decreasing phase of relative humidity. The excess deaths at decreasing atmospheric pressure were recognized in every season. For the interpretation of this finding other meteorologic factors such as the decreasing duration of sunshine and the amount of precipitation may have to be taken into consideration, as the decrease of atmospheric pressure is generally considered to be concomitant with so-called bad weathers. In autumn the excess deaths at increasing as well as at decreasing atmospheric pressure were interestingly noted. The frequent attacks of tropical cyclones or typhoons in early autumn and the migrations of anticyclones in late autumn are typical meteorologic features in Nagoya.³ The larger variations of atmospheric pressure and of other meteorologic factors with the frequent weather changes may be attributed to the finding in autumn.

The significant relationships of the variations of air temperature gradient and of relative humidity gradient with the deaths were found. The

findings certainly suggest that the variations of gradient have some physiological effects which were likewise proved on the absolute values and the gradients of meteorologic factors. Neither experimental or fundamental studies on the variations of gradient of meteorologic factors have been accomplished, nor their physiological significance has been reported. Therefore the further studies are required for the clearer interpretations of their effects on the deaths from cerebrovascular accidents.

It was revealed in the present study that the clear seasonal differences in meteorologic effects were noted on the deaths from cerebrovascular accidents. Some meteorologic factors were disadvantageous in one season but not in another season, and some were harmful throughout all seasons. The seasonal differences indicate the possible contributions to the deaths not only of other meteorologic factors not considered in this study but also of various ecological factors such as clothings, dwelling conditions and so forth.

And the present study properly suggests that some harmful meteorologic factors can be made to be harmless by various artificial measures and therefore some of the deaths from cerebrovascular accidents could surely be prevented by the controls of meteorological factors.

To the further elucidation of ecological factors closely associated with cerebrovascular diseases the researches should be directed, which may furnish the additional preventive measures against them.

The author's studies described in both the first and the second report could be also presumed as the first step towards the clarification of the possible relationships between the occurrence of cerebrovascular accidents and the meteorologic factors or their changes.

CONCLUSION

In order to identify and to evaluate ecological factors in the light of seasonal differences in the effects of meteorologic factors, an analysis on 1,075 deaths from cerebral hemorrhage and 527 deaths from cerebral infarction was accomplished and revealed:

1. Meteorological conditions contributing to the excess deaths from cerebral hemorrhage and those from cerebral infarction were: low temperature-humidity index and low MISSENARD's effective temperature in spring; high air temperature, low relative humidity and high temperature-humidity index in summer; increasing atmospheric pressure in autumn; and increase of negative gradient or decrease of positive gradient of air temperature in low air temperature range.

2. Meteorological conditions contributing to the excess deaths from cerebral hemorrhage were: low air temperature in spring; increasing air temperature and decreasing relative humidity in high air temperature range; increasing humidity in low temperature range; decreasing atmospheric pressure in all seasons; increase of positive humidity gradient or decrease of negative humidity gradient in winter, spring and summer; increase of negative humidity gradient or decrease of positive humidity

gradient in summer; and increase of positive temperature gradient or decrease of negative temperature gradient in high temperature range.

3. Meteorological conditions contributing to the excess deaths from cerebral infarction were: low relative humidity in autumn and decreasing atmospheric pressure in summer.

4. It was revealed that the differences in meteorological conditions between the outdoors and the indoors should be taken into consideration, especially in winter.

5. The effects of the variations of gradient of air temperature and of relative humidity were recognized as significant.

6. The seasonal differences in the effects of meteorologic factors or their changes were clearly noted and they properly indicate the contributions of various ecological factors such as clothings and dwelling conditions or the effects of meteorological factors not considered in this study on cerebrovascular diseases.

7. It was proved that some of the deaths from cerebrovascular diseases could be prevented by the adequate controls of meteorologic factors.

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REFERENCES

1. Chubu Electric Power Co., Ltd.: A public opinion census concerning electric enterprise in Chubu district. 1965.
2. Inogawa, T. and Taga, M.: Relation between meteorological condition and death (Report 1). *Jap. J. Publ. Health* 10 (7): 389, 1963. (in Japanese)
3. Nagoya Weather Bureau: Meteorologic data in Aichi. Nagoya, 1962.
4. Ohno, Y.: Biometeorologic studies on cerebrovascular diseases. I. Effects of meteorologic factors on the death from cerebrovascular accident. *Jap. Circulation J.* 34; 1285, 1969.
5. Personal communication with Toho Gas Co., Ltd. in Nagoya.