

Study of Atomic Bomb Survivors
— Postmortem Examination in The Nagasaki
District over A 32-Year Period—

Masao KISHIKAWA* and Issei NISHIMORI*,**

* *Department of Pathology, Scientific Data Center of Atomic
Bomb Disaster, Nagasaki University School of Medicine*

** *Department of Pathology, Atomic Disease Institute, Nagasaki
University School of Medicine*

Received for publication: May 10, 1981

More than twelve thousand autopsies were performed in Nagasaki district after World War II. From those cases 9,331 were selected, since the patients were born before the time of atomic bomb (AB). They were examined for main histopathological changes, which were classified. Studies were made to elucidate the rise and fall in these changes and determine whether there was a difference in such changes between the group exposed to AB and that non-exposed to AB or not. Statistical examination was also performed in the present investigation to determine whether there were differences among calendar years, age groups, and combinations of age group and calendar year. A significant difference was shown independently in some groups. In the present investigation the autopsy cases dealt with in the whole Nagasaki district were used as controls. Therefore, the results obtained seem to be satisfactory data available for clarification of the actual state and trend in each period of the main lesions of cases of exposure to AB.

INTRODUCTION

More than 12,000 autopsies have been performed in Nagasaki district for the past 35 years since exposure to the atomic bomb (AB). All of them have been examined histopathologically in detail. The results obtained were compared between cases exposed and those not exposed to AB in the following two institutions: Department of Pathology, Scientific Data Center of Atomic Bomb Disaster, Nagasaki University School of Medicine, and the Department of Pathology, Atomic Disease Institute, Nagasaki University School of Medicine. As a result, several papers have been published by these institutions to

岸川正大, 西森一正

This work was supported in part by Grant from the Ministry of Health and Welfare of Japan.

report the results of the pathological and statistical analysis of AB survivors within 2 km from the hypocenter in Nagasaki conducted every five years³⁾, and to describe hepatic lesions⁶⁾ and multiple primary malignant tumors⁵⁾.

Data on pathological diagnoses of the autopsy cases made over a 32-year period of 1946 to 1977 have been classified and filed completely already. The present investigation was carried out particularly on cases which were born before the time of AB.

MATERIALS AND METHODS

The subjects used were all the patients born before the time of AB, those had been dissected in the Nagasaki University School of Medicine, the Radiation Effects Research Foundation at Nagasaki (formerly the Atomic Bomb Casualty Commission), the Nagasaki Atomic Bomb Hospital of the Japan Red Cross, and the Nagasaki Municipal Hospital. They were divided into three groups, 1 to 3, by the condition of exposure to AB. The patients were within and over 2 km from the hypocenter at the time of AB in groups 1 and 2, respectively. Group 2 also consisted of the early entrants, who entered Nagasaki City immediately after or within 2 weeks after the time of AB to be exposed to residual radiation near the hypocenter. A group of inhabitants not exposed to AB served as control (group 3). Cases, which condition of exposure to AB was unknown, were classified into the control group. Those who had been exposed to AB in their intrauterine life, and the children and grandchildren of those who had been exposed to AB were excluded from the subjects of the present investigation.

All the subjects were divided into groups of the following diseases on the basis of main histopathological changes: hepatic diseases, hematological diseases (diseases of the hematopoietic and lymphoid system), cardiovascular disorders (except those of the central nervous system), hypertensive cerebral hemorrhage, infectious diseases of the lower respiratory system, collagen disease, malignant tumor, etc. Each group was examined for (1) the condition of exposure to AB and the number of morbid cases (autopsy cases) by every five years, (2) the proportion to the number of autopsy cases, (3) a rise and fall in morbidity by calendar year and patient's age, and (4) the distribution of morbidity in age groups.

RESULTS

Of the cases subjected to autopsy in the Nagasaki district, 9,331 cases involved those who were born before the time of AB (Table 1). They consisted of 3,544 cases of exposure to AB and 5,787 cases of non-exposure to AB (group 3). Of the former cases, 734 cases belonged to group 1 and 2,810 cases to group 2. Of the patients of 734 cases, 122 patients were within 1 km from the hypocenter and the other 612 patients were 1 to 2 km from the hypocenter at the time of AB.

Main histopathological changes manifested in each calendar year are shown in Table 2.

Table 1. *Autopsy Cases in Nagasaki District*

Years	Total Number of Autopsy	Exposed Cases			Non-exposed Cases
		0~1 km	~2 km	2 km~and Early Entrants	
1946-1950	115	3	8	20	84
1951-1955	602	6	25	213	358
1956-1960	1349	11	65	497	776
1961-1965	2180	35	218	607	1320
1966-1970	2694	30	169	780	1715
1971-1975	1759	31	100	534	1094
1976-1977	632	6	27	159	440
Total	9331	122	612	2810	5787

Table 2. *Main Histopathological Changes*

Years	Total Number of Autopsy	Hepatic Disease	Hematological Disease	Cardiovascular Disease	Hypertensive Cerebral Hemorrhage	Infections of Lower Respiratory System	Collagen Disease	Malignant Tumor
1946-1950	115	10(8.7%)	11(9.6%)	2(1.7%)	2(1.7%)	31(30.0%)	1(0.9%)	33(28.7%)
1951-1955	602	81(13.5)	41(6.8)	55(9.1)	15(2.5)	146(24.3)	0(0)	214(35.5)
1956-1960	1349	137(10.2)	92(6.8)	103(7.6)	68(5.0)	318(23.6)	11(0.8)	573(42.5)
1961-1965	2180	257(11.8)	180(8.3)	208(9.5)	78(3.6)	368(16.9)	13(0.6)	1038(47.6)
1966-1970	2694	414(15.4)	252(9.4)	260(9.7)	75(2.8)	334(12.4)	16(0.6)	1423(52.8)
1971-1975	1759	266(15.1)	217(12.3)	148(8.4)	50(2.8)	128(7.3)	19(1.1)	1088(61.9)
1976-1977	632	94(14.9)	63(10.0)	18(9.2)	12(1.9)	52(8.2)	12(1.9)	428(67.7)
Total	9331	1259(13.5)	856(9.2)	834(8.9)	300(3.2)	1377(14.8)	72(0.8)	4797(51.4)

In it, infectious diseases of the lower respiratory system were exhibited by 1,377 cases (14.8%), hepatic diseases by 1,259 cases (13.5%), and hematological diseases by 856 cases (9.2%). The group of hepatic diseases was classified into four subgroups, hepatitis, hepatic cirrhosis, hepatic cirrhosis and hepatic carcinoma, and hepatic carcinoma. The frequency of appearance of each subgroup is shown in Table 3. When it was analyzed by the age group, hepatic cirrhosis and hepatic carcinoma were both prevalent in the forties and the fifties (Table 4).

Of the hematological diseases, leukemia was predominant in the autopsy cases encountered up to 1960. Over a period of 1961 to 1965 leukemia decreased in frequency to 3.3% to be inferior to malignant lymphoma the frequency of which was 3.8%. Thereafter, autopsy cases of malignant lymphoma have increased in number (Table 5). The frequency of hematological diseases was analyzed by calendar year and the condition of exposure to AB. Leukemia showed a high frequency of appearance, or 27.3 and 25.8%, in group 1 (exposed within 2 km from the hypocenter) examined for a period of 1946 to 1950 and a period of 1951 to 1955 respectively (Table 6). Malignant lymphoma did not show so

Table 3. *Hepatic Disease*

Years	Condition of Exposure(Group)	Hepatitis	Hepatic Cirrhosis	Cirrhosis and Carcinoma	Hepatic Carcinoma
		%	%	%	%
1946	1	0(0)	1(9.1)	0(0)	0(0)
	2	0(0)	1(5.0)	1(5.0)	0(0)
1950	3	1(1.2)	1(1.2)	4(4.8)	0(0)
1951	1	0(0)	3(9.7)	0(0)	0(0)
	2	3(1.4)	9(4.2)	2(0.9)	1(0.5)
1955	3	7(2.0)	26(7.3)	11(3.1)	6(1.7)
1956	1	2(2.6)	4(5.3)	3(3.9)	0(0)
	2	6(1.2)	20(4.0)	17(3.4)	5(1.0)
1960	3	6(0.8)	28(3.6)	24(3.1)	4(0.5)
1961	1	4(1.6)	4(1.6)	7(2.8)	1(0.4)
	2	4(0.7)	29(4.8)	23(3.8)	2(0.3)
1965	3	8(0.6)	71(5.4)	49(3.7)	14(1.1)
1966	1	2(1.0)	13(6.5)	7(3.5)	2(1.0)
	2	18(2.3)	38(4.9)	36(4.6)	4(0.5)
1970	3	27(1.6)	99(5.8)	77(4.5)	22(1.3)
1971	1	4(3.1)	1(0.8)	3(2.3)	5(3.8)
	2	13(2.4)	25(4.7)	24(4.5)	2(0.4)
1975	3	24(2.2)	61(5.6)	42(3.8)	23(2.1)
1976	1	0(0)	0(0)	0(0)	1(3.0)
	2	2(1.3)	8(5.0)	5(3.1)	3(1.9)
1977	3	6(1.4)	23(5.2)	27(6.1)	14(3.2)

$$\left(\frac{\text{Number of each disease}}{\text{Total of each group in one period}} \times 100 \right)$$

Table 4. *Hepatic Disease*

Ages	Condition of Exposure(Group)	Hepatitis	Hepatic Cirrhosis	Cirrhosis and Carcinoma	Hepatic Carcinoma
		%	%	%	%
0	1	1(7.1)	1(7.1)	0(0)	0(0)
	2	1(3.6)	1(3.6)	0(0)	0(0)
19	3	1(1.6)	3(4.8)	0(0)	0(0)
20	1	3(3.6)	3(3.6)	0(0)	1(1.2)
	2	1(0.3)	8(2.7)	6(2.0)	1(0.3)
39	3	13(1.4)	42(4.4)	14(1.5)	3(0.3)
40	1	4(2.2)	12(6.6)	8(4.4)	1(0.5)
	2	13(1.7)	63(8.3)	52(6.8)	8(1.1)
59	3	32(1.3)	164(6.7)	159(6.5)	50(2.1)
60	1	4(1.0)	9(2.3)	11(2.8)	5(1.3)
	2	27(1.8)	54(3.6)	49(3.3)	8(0.5)
79	3	31(1.4)	97(4.5)	61(2.8)	28(1.3)
80	1	0(0)	1(1.8)	1(1.8)	2(3.5)
	2	4(1.7)	4(1.7)	1(0.4)	0(0)
	3	2(1.1)	3(1.6)	0(0)	2(1.1)

$$\left(\frac{\text{Number of each disease}}{\text{Total of each group in ages}} \times 100 \right)$$

remarkable a fluctuation as leukemia. It appeared rather frequently in the cases of non-exposure to AB over a period of 1971 to 1975 and a period of 1976 to 1977 (Table 6).

Diseases of the circulatory system were analyzed on frequency by calendar year, as shown in table 7. Almost all the cases of cardiovascular diseases were myocardial infarction and only a few cases congenital heart diseases. For a period of 1961 to 1965 and a period of 1966 to 1970 the frequency was 11.5 to 12.6% in the cases of exposure to AB and 8.2% in the cases of non-exposure to AB. When hypertensive cerebral hemorrhage

Table 5. *Hematological Disease*

Years	Total Number of Autopsy	Leukemia	Malignant Lymphoma	Multiple Myeloma	Aplastic Anemia
1946-1950	115	6(5.2) [%]	4(3.5) [%]	0(0) [%]	1(0.9) [%]
1951-1955	602	26(4.3)	7(1.2)	0(0)	3(0.5)
1956-1960	1349	47(3.5)	35(2.6)	5(0.4)	3(0.2)
1961-1965	2180	72(3.3)	82(3.8)	13(0.6)	9(0.4)
1966-1970	2694	90(3.3)	110(4.1)	17(0.6)	21(0.8)
1971-1975	1759	77(4.4)	106(6.0)	13(0.7)	11(0.6)
1976-1977	632	15(2.4)	41(6.5)	2(0.3)	2(0.3)

Table 6. *Hemotological Disease*

Years	Condition of Exposure(Group)	Leukemia	Malignant Lymphoma	Multiple Myeloma	Aplastic Anemia
1946	1	3(27.3) [%]	0(0) [%]	0(0) [%]	0(0) [%]
	2	1(5.0)	0(0)	0(0)	1(5.0)
1950	3	2(2.4)	4(4.8)	0(0)	0(0)
1951	1	8(25.8)	1(3.2)	0(0)	2(6.5)
	2	9(4.2)	1(0.5)	0(0)	1(0.5)
1955	3	9(2.5)	5(1.4)	0(0)	0(0)
1956	1	6(7.9)	3(3.9)	0(0)	0(0)
	2	18(3.6)	12(2.4)	3(0.6)	1(0.2)
1960	3	23(3.0)	20(2.6)	2(0.3)	2(0.3)
1961	1	11(4.3)	8(3.2)	0(0)	0(0)
	2	20(3.3)	16(2.6)	2(0.3)	4(0.7)
1965	3	41(3.1)	58(4.4)	11(0.8)	5(0.4)
1966	1	4(2.0)	5(2.5)	2(1.0)	0(0)
	2	20(2.6)	23(2.9)	2(0.3)	2(0.3)
1970	3	66(3.8)	82(4.8)	13(0.8)	19(1.1)
1971	1	4(3.1)	4(3.1)	1(0.8)	1(0.8)
	2	26(4.9)	16(3.0)	6(1.1)	3(0.6)
1975	3	47(4.3)	86(7.9)	6(0.5)	7(0.6)
1976	1	0(0)	0(0)	1(3.0)	0(0)
	2	3(1.9)	8(5.0)	1(0.6)	2(1.3)
1977	3	12(2.7)	33(7.5)	0(0)	0(0)

$$\left(\frac{\text{Number of each disease}}{\text{Total of each group in one period}} \times 100 \right)$$

Table 7. *Circulatory Disorders*

Years	Condition of Exposure(Group)	Cardiovascular Lesion(except CNS)	Hypertensive Cerebral Hemorrhage	Other Cardiovascular Lesion
		%	%	%
1946	1	0(0)	0(0)	0(0)
	2	0(0)	0(0)	1(5.0)
1950	3	2(2.4)	2(2.4)	1(1.2)
1951	1	1(3.2)	0(0)	0(0)
	2	22(10.3)	6(2.8)	12(5.6)
1955	3	32(8.9)	9(2.5)	12(3.4)
1956	1	7(9.2)	3(3.9)	2(2.6)
	2	40(8.0)	25(5.0)	28(5.6)
1960	3	56(7.2)	40(5.2)	34(4.4)
1961	1	29(11.5)	7(2.8)	20(7.9)
	2	71(11.7)	23(3.8)	43(7.1)
1965	3	108(8.2)	48(3.6)	73(5.5)
1966	1	25(12.6)	10(5.0)	19(9.5)
	2	95(12.2)	27(3.5)	61(7.8)
1970	3	140(8.2)	38(2.2)	81(4.7)
1971	1	13(9.9)	4(3.1)	16(12.2)
	2	47(8.8)	25(4.7)	43(8.1)
1975	3	88(8.0)	21(1.9)	42(3.8)
1976	1	2(6.1)	2(6.1)	3(9.1)
	2	18(11.3)	2(1.3)	8(5.0)
1977	3	38(8.6)	8(1.8)	17(3.9)

$$\left(\frac{\text{Number of each disease}}{\text{Total of each group in one period}} \times 100 \right)$$
Table 8. *Infection and Collagen Disease*

Years	Condition of Exposure(Group)	Infection of Lower Respiratory System	Other Infection	Collagen Disease
		%	%	%
1946	1	3(27.3)	1(9.1)	0(0)
	2	4(20.0)	4(20.0)	0(0)
1950	3	24(28.6)	8(9.5)	1(1.2)
1951	1	9(29.0)	6(19.4)	0(0)
	2	53(24.9)	36(16.9)	0(0)
1955	3	84(23.5)	56(15.6)	0(0)
1956	1	15(19.7)	6(7.9)	1(1.3)
	2	145(29.2)	54(10.9)	6(1.2)
1960	3	158(20.4)	73(9.4)	4(0.5)
1961	1	54(21.3)	20(7.9)	2(0.8)
	2	117(19.3)	58(9.6)	5(0.8)
1965	3	197(14.9)	142(10.8)	6(0.5)
1966	1	32(16.1)	8(4.0)	2(1.0)
	2	105(13.5)	59(7.6)	2(0.3)
1970	3	197(11.5)	199(11.6)	12(0.7)
1971	1	19(14.5)	11(8.4)	2(1.5)
	2	39(7.3)	50(9.4)	7(1.3)
1975	3	70(6.4)	70(6.4)	10(0.9)
1976	1	2(6.1)	0(0)	0(0)
	2	11(6.9)	10(6.3)	5(3.1)
1977	3	39(8.7)	35(8.0)	7(1.6)

$$\left(\frac{\text{Number of each disease}}{\text{Total of each group in one period}} \times 100 \right)$$

was examined over a period of 1966 to 1970, it appeared in 10 cases (5%) of group 1 and in 38 cases (2.2%) of group 3.

Autopsy cases with infection as a principal disorder have recently come to be very few, or less than 10% (Table 8). Collagen disease appeared in 72 cases (0.8%) for a period of 32 years.

DISCUSSION

Studies were made on main histopathological changes in patients who had been born before the time of AB and subjected to postmortem examination in the Nagasaki district over a 32-year period after World War II. It is understandable that the frequency of a disease in the autopsy cases, which are the special population, does not directly indicate the accurate frequency of the disease. It is possible, however, to elucidate the characteristic of the rise and fall in frequency of the main histopathological changes in the Nagasaki district as compared with Annual of the Pathological Autopsy Cases in Japan issued by the Japanese Pathological Society.

In the whole Japan a total of 49,965 autopsy cases⁸⁾ have been described over a period of 1976 to 1977. Of them, 28,478 cases (57%) were of malignant tumor. It is well known that malignant tumor is increasing rapidly in frequency year by year. This is also the case with the Nagasaki district. In this district the frequency of malignant tumor was 67.7%, or about 10% higher than the mean of this frequency in Japan, over a period of 1976 to 1977 (Fig. 1). When it was analyzed, gastric and lung cancer were predominant in frequency (9.4 and 6.9%, respectively) and followed by liver cancer (4.9%), malignant lymphoma (3.9%), and leukemia (3.0%) in the order listed, as already reported⁸⁾.

It has been known since a considerably long time ago that hepatic diseases, especially cirrhosis and carcinoma, are high in morbidity in the Nagasaki district. In his clinical and pathological studies, Matsukuma⁴⁾ found that the frequency of appearance of cirrhosis and carcinoma of the liver in this district was about 1.5 times as high as that in the whole country. The present authors⁶⁾ also reported similar results. In the present investigation, this frequency was calculated for a five-year period (Table 3 ; Fig. 2). In 1976 to 1977, the frequency of hepatic cirrhosis and carcinoma was about 6.0 and about 5.6%, respectively, in the whole country⁸⁾. When it was examined in the total cases of exposure and non-exposure to AB in the Nagasaki district, it was 10% for the cirrhosis and 8% for the carcinoma ; that is, 1.7 and 1.4 times, respectively, as high as that in the whole country. The statistical independence test of each disorder was carried out between the cases of exposure and those of non-exposure to AB, but revealed little difference in results between the two groups of cases. Even when the frequency was compared among the age groups, hepatic cirrhosis and carcinoma were relatively frequent in the forties and the fifties (Fig. 3). These results were not different at all from those obtained by previous clinical investigators. Judging from the conditions of food supply in the

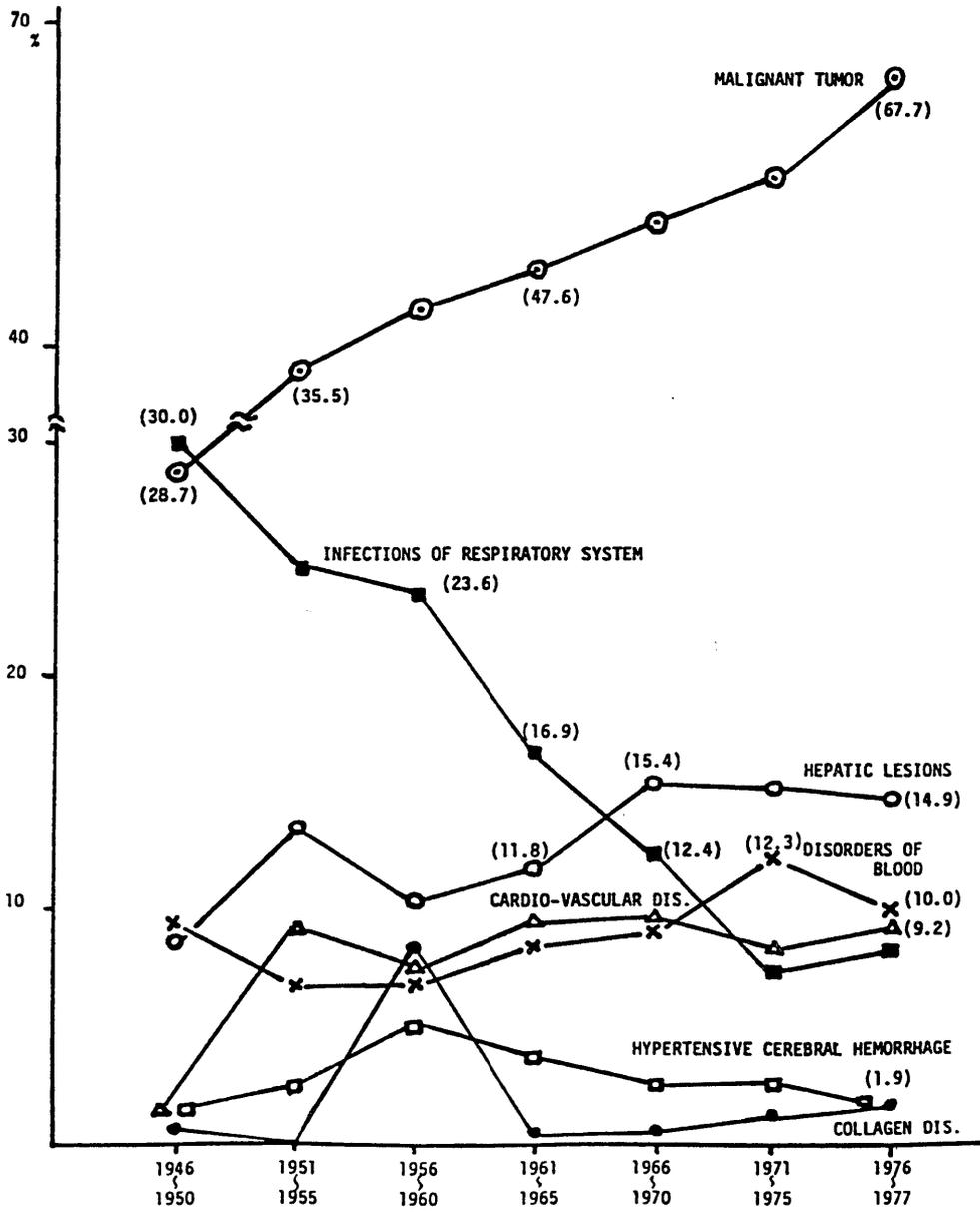


Fig. 1. Main Lesions of Autopsies

post-war days, it seemed necessary to take such factors as social circumstances at that time and the interval of time between exposure to AB and the onset of clinical symptoms into consideration. Then, cases of hepatic cirrhosis alone and cases of hepatic carcinoma complicated with cirrhosis were examined for age distribution in the chronological period. As a result, they appeared with the forties and the fifties as a peak in every chronological period (Figs. 4 and 5). Moreover, there was no difference in the pattern of appearance of either disorder at all between the two groups of cases. So far as investigation based on the results of autopsy is concerned, it is impossible to conclude that hepatic cirrhosis and carcinoma occur readily to the cases of exposure to AB. It is generally believed that the liver itself is strongly resistant to radioactive rays⁶⁾. On the other hand, it is also a fact that hepatic disorders have been found to various extents in those exposed to the attack with a hydrogen bomb in the experiment on the Bikini⁷⁾. In fact, the liver is an organ acting as a center of metabolic function, and hepatic dysfunction is induced in relation to the disturbance of some other organ. Therefore, it is impossible to neglect such hepatic disorders as caused by dysfunction after exposure to AB. It seems necessary to continue comprehensive studies on hepatic disorders in future.

Hematological diseases are among those which attract the authors' interest most strongly. There had been many autopsy cases of leukemia until 1960. That condition was

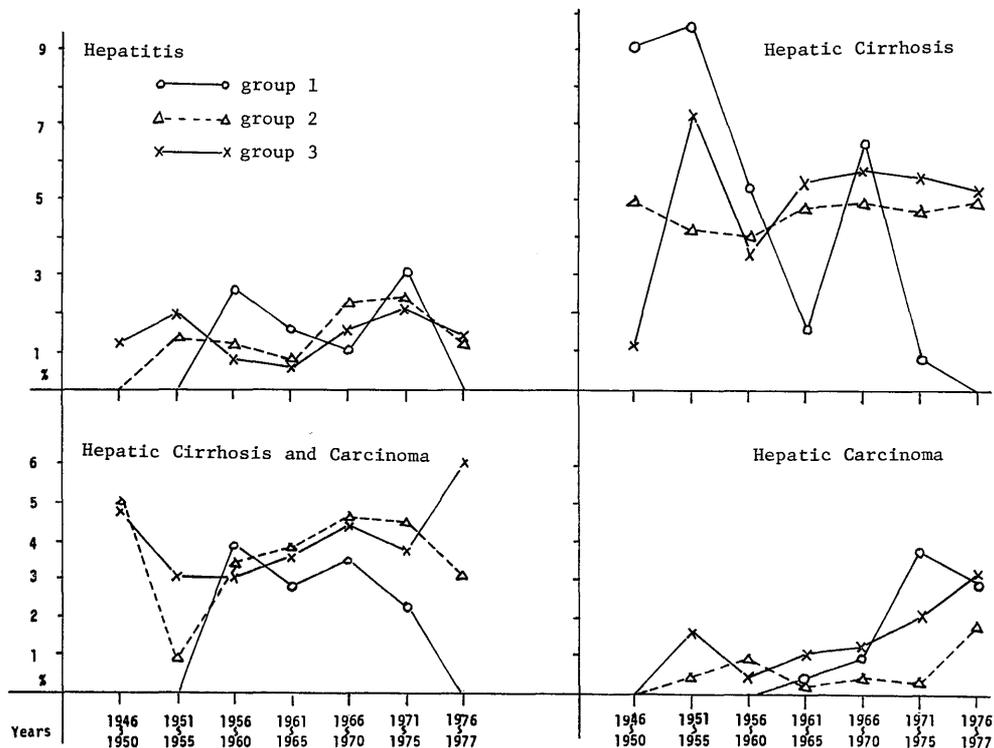


Fig. 2. Hepatic Disease

changed over a period of 1961 to 1965. In this period the frequency of appearance was 3.3% for leukemia and 3.8% for malignant lymphoma (Table 5 ; Fig. 6). After this period malignant lymphoma increased in frequency to reach 6.5% in 1976, when the frequency of leukemia was 2.4%. When all the autopsy cases were examined in the whole country⁸⁾, malignant lymphoma was found in 2.9% and leukemia in 4.5% of them. In the Nagasaki district, the frequency of the former was 2.2 times and that of the latter 1.9 times as high as the respective frequency in the whole country. It is of great interest to note that T-cell lymphoma was reported by Ichimaru et al.²⁾ to be higher in frequency in the Kyushu district than in the whole country.

These cases of hematological diseases were analyzed by the condition of exposure to AB. The results of analysis were already reported³⁾. In two surveys conducted over a period of 1946 to 1950 and of 1951 to 1955, respectively, the frequency of these diseases was high, or 27.3 and 25.8%, respectively, in group 1 (exposure within 2 km from the hypocenter) (Table 6). When it was processed statistically, there was a significant dif-

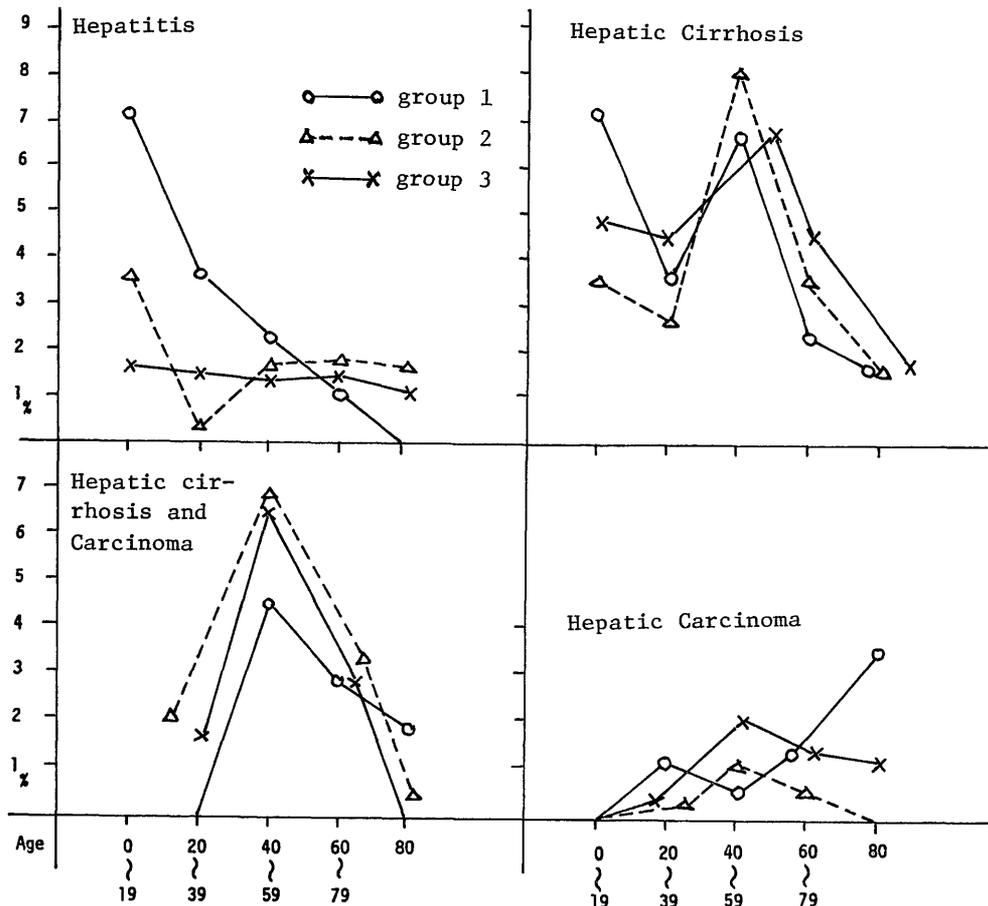


Fig. 3. The frequency of hepatic diseases is compared among the age groups.

ference in it between group 1 and group 3 (the non-exposed control group) in the survey over a period of 1946 to 1950. This conclusion may not be free from criticism, since the autopsy cases were very few in this period. Furthermore, in the survey conducted a period of 1951 to 1955, there was a significant difference at a significance level of 1% in group 1 (exposure within 2 km), group 2 (exposure more than 2 km and the early entrants), and group 3 (the non-exposed control group). Malignant lymphoma did not so markedly vary in frequency of appearance with the calendar year as leukemia. It can be mentioned, however, that malignant lymphoma was significantly higher in frequency at significance level of 1% in group 3 than in any exposed group in the survey conducted over a period of 1971 to 1975. Previously, the present authors³⁾ reported that cases of all the hematological diseases were significantly more in the non-exposed control group than in any exposed group in the survey conducted over a period of 1971 to 1975. There was

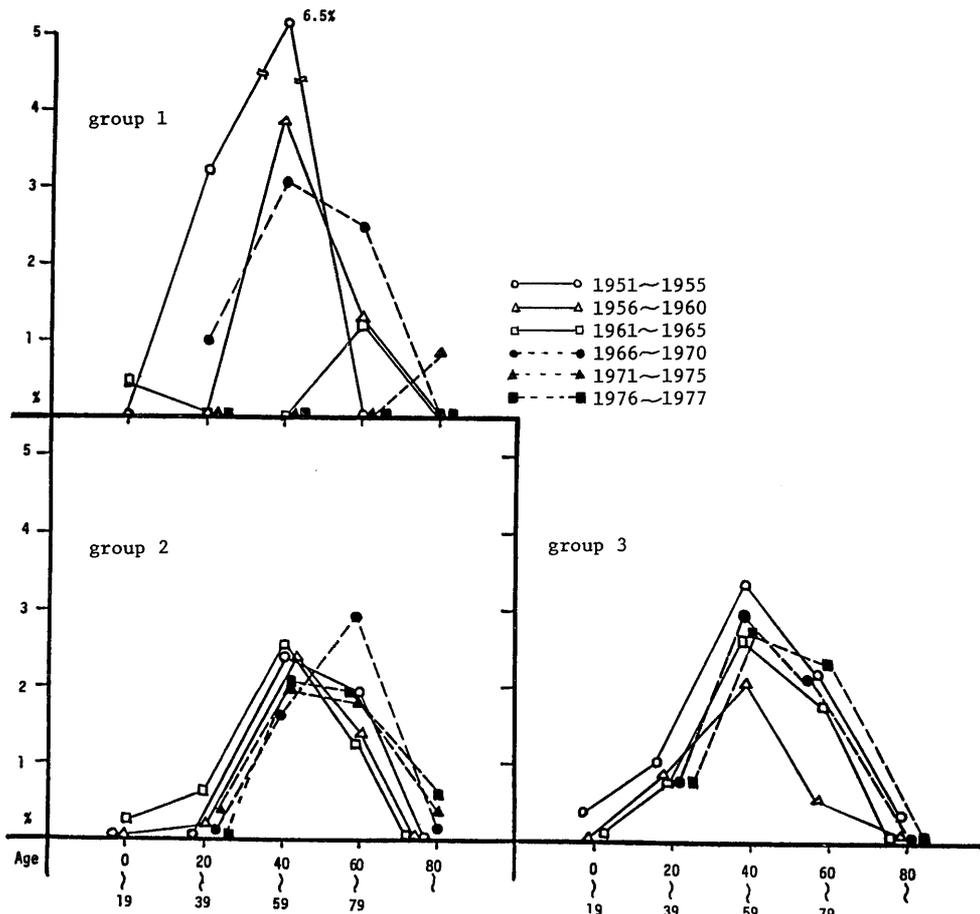


Fig. 4. Frequency of hepatic cirrhosis was examined for age distribution in the chronological period.

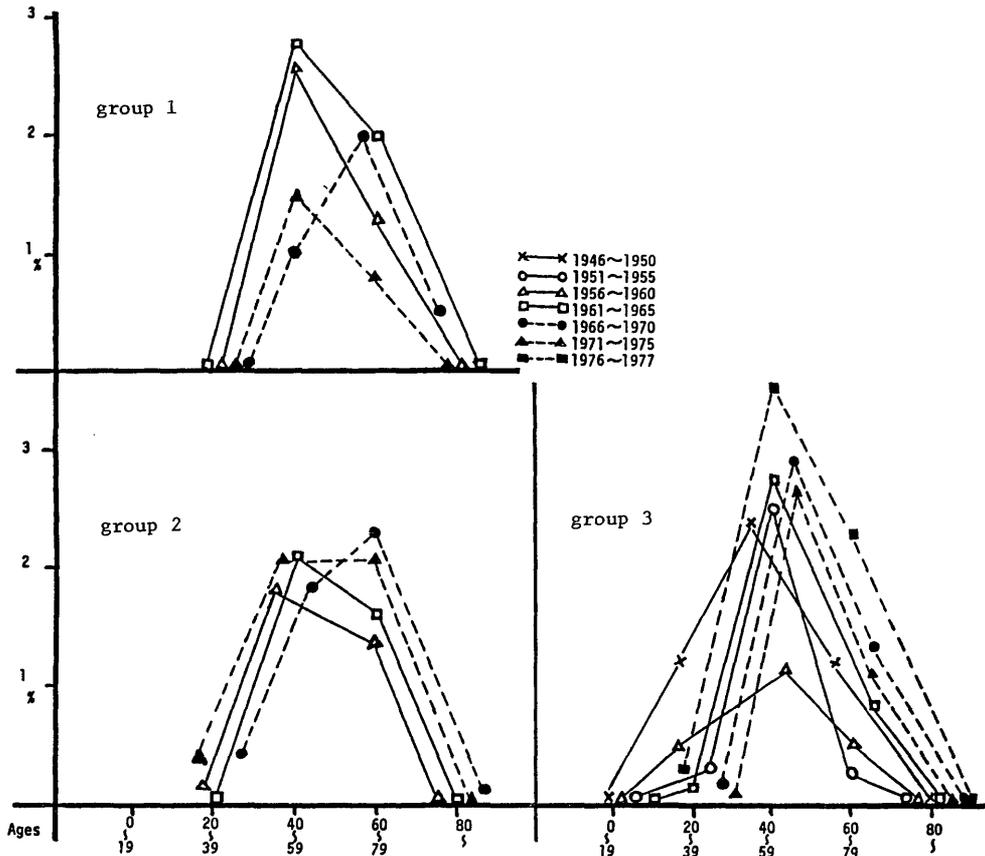


Fig. 5. Frequency of hepatic carcinoma complicated with cirrhosis was examined for age distribution in the chronological period.

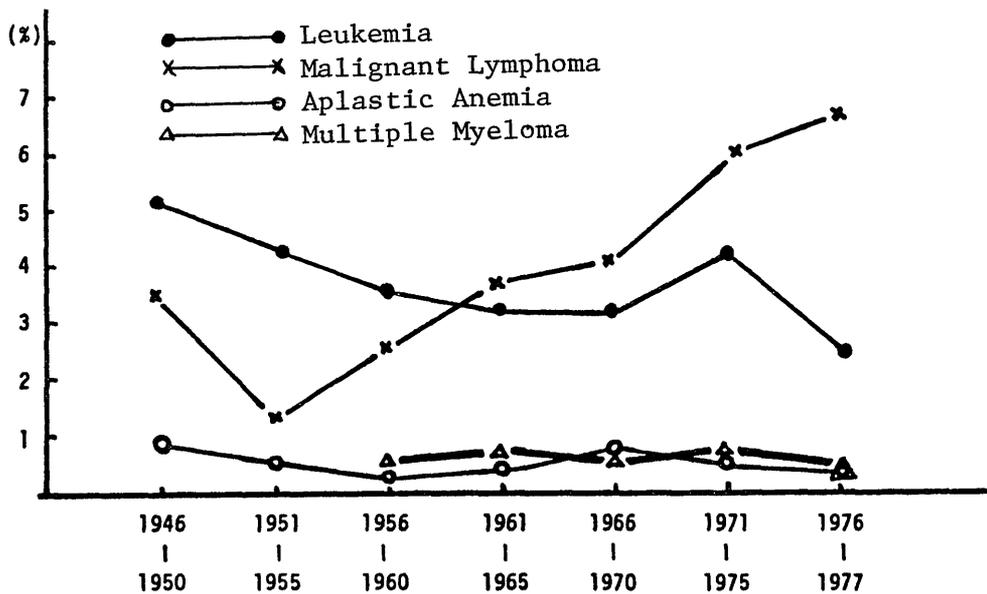


Fig. 6. Hematological diseases were examined for a rise and fall in morbidity by calendar year.

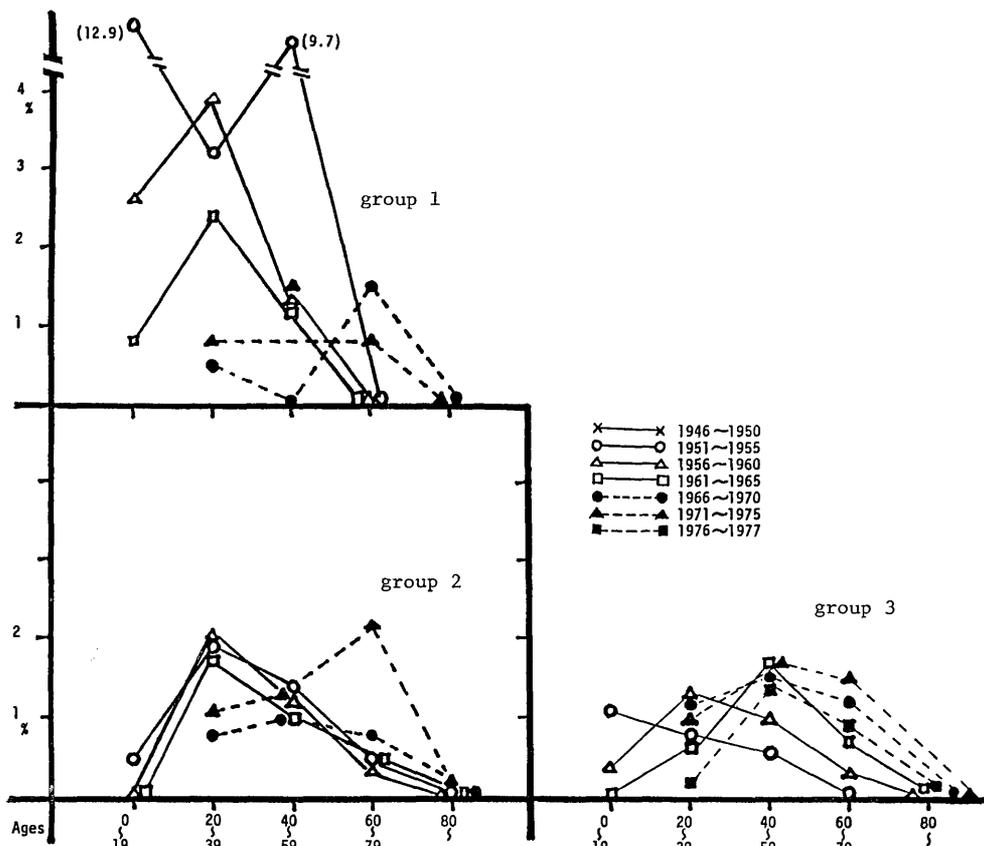


Fig. 7. The frequency of appearance by age group in each calendar year was expressed in the same coordinates. Leukemia group.

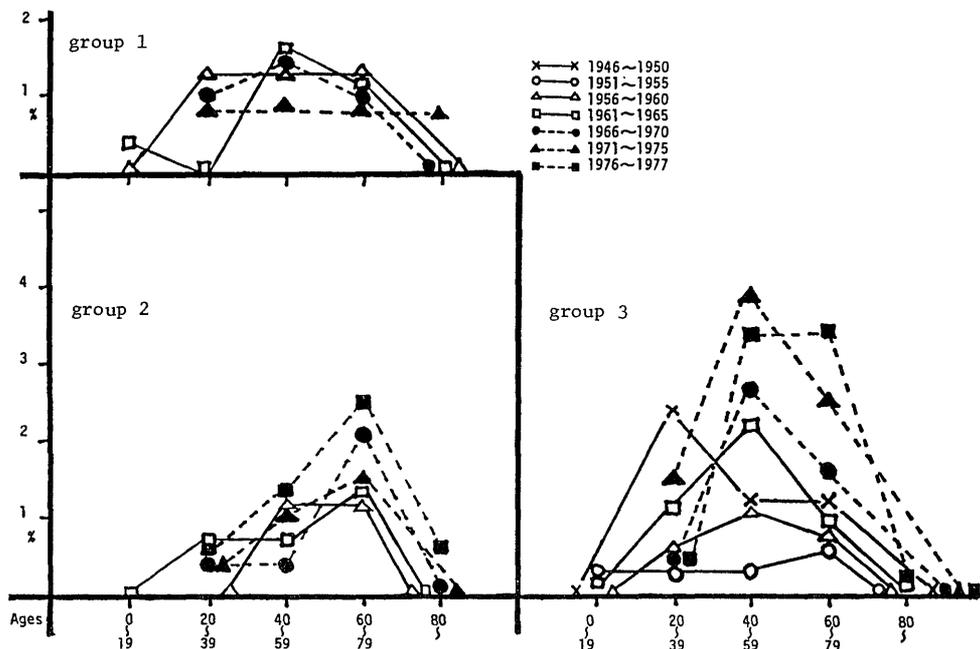


Fig. 8. Malignant lymphoma appeared frequently in age groups of 40 to 79 years in the case of any condition to exposure and in any calendar year.

no difference at all in frequency of appearance of leukemia itself between these groups (Table 6). From these results it is shown that the high frequency of hematological diseases in previous report might be due to the number of malignant lymphoma in group 3.

To determine whether there was a regularity between the age at the time of exposure to AB and the calendar year of examination, the frequency of appearance by age group in each calendar year was expressed in the same coordinates. As a result, the frequency of appearance of leukemia seemed to be high in the twenties and the thirties during a relatively early period, or until about 1960 (Fig. 7). This result was consistent with that obtained by Ichimaru¹⁾ who pointed out that leukemia was observed frequently in those exposed to AB in young days. On the other hand, malignant lymphoma appeared frequently in age groups of 40 to 79 years in both exposed and non-exposed cases in any calendar year (Fig. 8).

The circulatory diseases examined in the present investigation were roughly divided into three groups, cardiovascular disturbances (except those of the central nervous system), hypertensive cerebral hemorrhage, and miscellaneous cardiovascular diseases. Almost all the cases of cardiovascular disturbances, except those of the central nervous system, were of myocardial infarctin. The others included cases of congenital heart diseases and aortic aneurysm, except cases of syphilitic nature. The frequency of the circulatory diseases seems to be higher in the exposed groups than in non-exposed group over a ten-year period of 1961 to 1970 (Table 7). The chi-square test revealed that it was significantly higher at a significance level of 1% in group 2 than in group 3 over a period of 1966 to 1970. When the frequency of appearance of hypertensive cerebral hemorrhage was examined, it was 5% in the 10 cases of group 1 and 2.2% in the 38 cases of group 3 in the survey conducted over a period of 1966 to 1970. When both groups were subjected to the independence test, a significant difference was not found at a significance level of 1%, but was noticed at a significance level of 5%. The frequency of that hemorrhage was 4.7% in the 25 cases of groups 2 and 1.9% in the 21 cases of group 3 in the survey conducted over a period of 1971 to 1975. These results indicated that hypertensive cerebral hemorrhage had exhibited a significantly higher frequency of appearance at a significance level of 1% in the exposed groups than in the non-exposed group.

When the frequency of the circulatory diseases was analyzed by age group, there was no significant difference at all in it, except that of such particular diseases as congenital cardiac ones, in the exposed or non-exposed group (Fig. 9). Then, taking the age at the time of exposure to AB and such environmental circumstances as restricted conditions of food supply into consideration, observation was made on frequency graphs drawn by calendar year and age of death. These graphs presented almost similar figures (Fig. 10). Judging from these results, the statistically significant difference mentioned above may be reasonably interpreted to have been produced, because the autopsy cases studied are regarded as a "special population" to which have been added such various complicated factors as the selection of these cases by the clinicians, the intention of the patients' families, the religious custom and the conventionalities of patients' residence.

By the way, there was a total of 1,862 cases (3.7%) of hypertensive cerebral hemorrhage in the whole Japan over a period of 1976 to 1977⁸⁾. In the Nagasaki district the frequency of appearance of this disorder was 1.9%, including those exposed to AB, over the same period and 2.8% for the past 10 years (only 3.2% for the past 32 years ; Table 2). Therefore, it was a little lower than the average frequency in the whole country. The item "miscellaneous cardiovascular diseases" was also set up. Such disorders as encephalomalacia were classified into it for discussion. That item, however, became a subject very difficult to discuss. To what extent are ischemic changes classified into the cerebral vascular changes? Was the intracranial examination performed in a given case at the time of autopsy? These problems were not settled. From the viewpoint of exposure to AB and

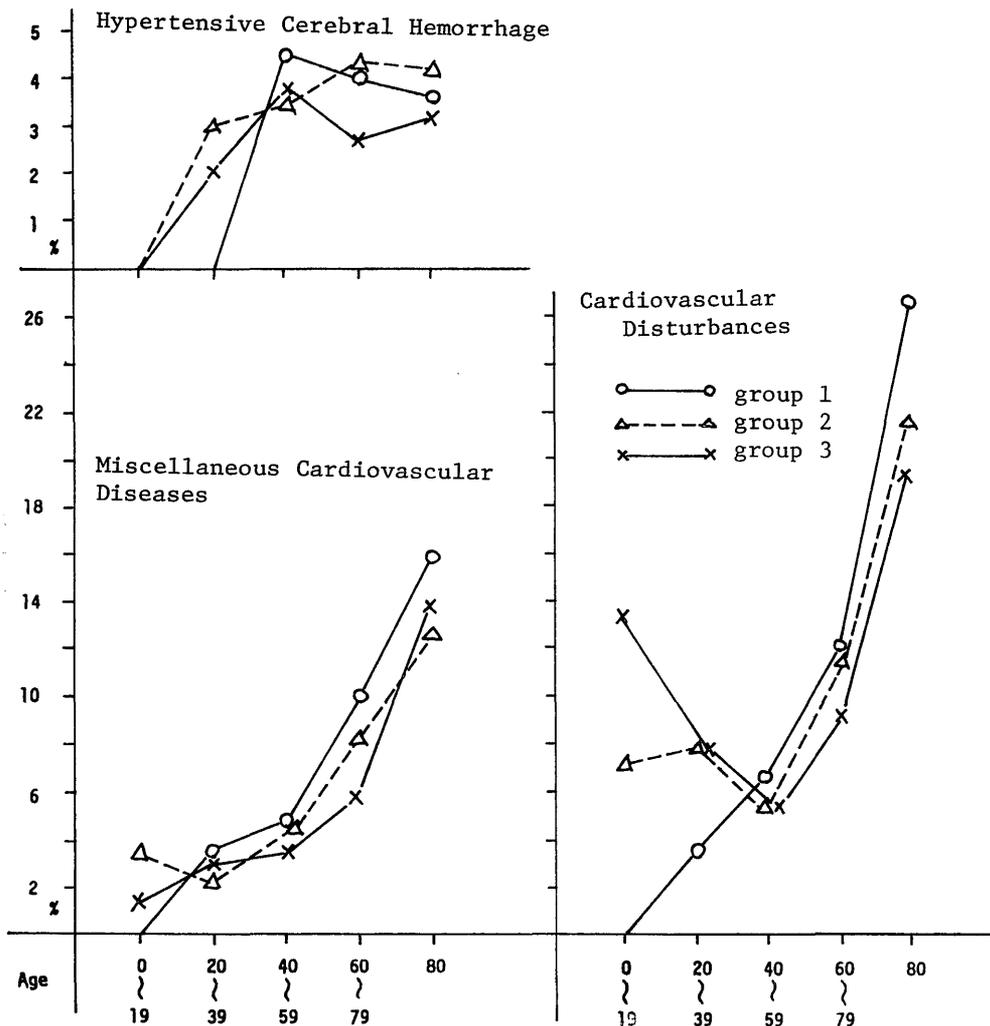


Fig. 9. Frequency of the circulatory diseases. There was no significant difference at all in any disease and in any group.

aging the discussion on that item seemed to be of great significance, but no data processing was carried out.

In the recent years malignant tumor has been increasing in morbidity, but there is a marked decrease in number of autopsy cases with respiratory infection as a main change (Table 2, Fig. 1). This trend has been in parallel with a remarkable progress in chemotherapy after World War II. It does not seem to be a doubtful phenomenon. It is revealed that those cases have been decreasing in both exposed and non-exposed groups with the lapse of time, drawing a similar curve of occurrence (Fig. 11).

There were 72 autopsy cases (0.8%) of collagen disease over a period of 32 years. According to the Annual of the Pathological Autopsy Cases in Japan⁹⁾, there were 404 autopsy cases (0.8%) of this disease in the whole country over a period of 1976 to 1977. The rate of autopsy cases of collagen disease was the same in the Nagasaki district as in the whole country. Moreover, there was no significant difference at all in this rate between the exposed and the non-exposed groups (Table 8).

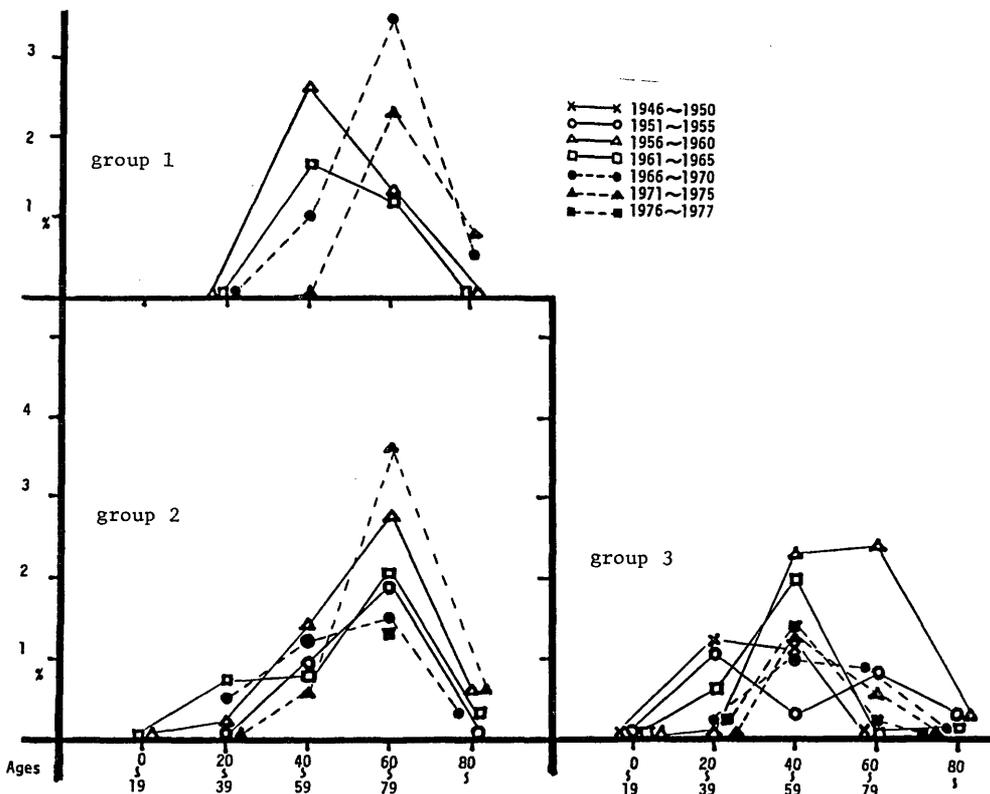


Fig. 10. The frequency graphs of hypertensive cerebral hemorrhage drawn by calendar year and age of death present almost similar figures.

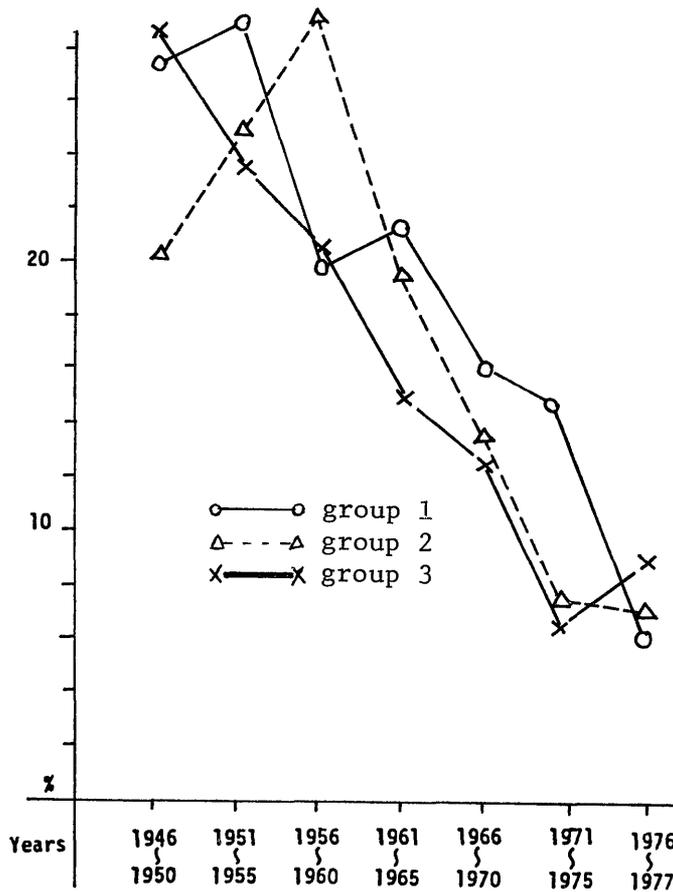


Fig. 11. The lower respiratory infection as a main change decreased in frequency.

ACKNOWLEDGMENTS

The authors wish to express their thanks to the departments of pathology of the following institutions for cooperation to the present research and investigation: the radiation Effects Research Foundation at Nagasaki, the Nagasaki Atomic Bomb Hospital of the Japan Red Cross, the Nagasaki Municipal Hospital, and the Nagasaki University School of Medicine. They are also grateful to the colleagues and research assistants of the Department of Pathology, Data Center of Atomic Bomb Disaster and Atomic Disease Institute, Nagasaki University School of Medicine, who extended a helping hand constantly to the preparation of data for the present research and investigation. They are indebted to Miss F. Tanaka for typewriting manuscript.

REFERENCES

- 1) ICHIMARU, M.: Symposium, Epidemiology of leukemia in Japan. Leukemia in survivors of the atomic bomb. 2. Nagasaki. *Acta Haemat. Jap.* 31 : 772—783, 1968 (*in Japanese*).
- 2) ICHIMARU, M., *et al.* : T-cell malignant lymphoma in Nagasaki district and its problems. *Jpn. J. Clin. Oncol.* 9(Suppl.) : 337—346, 1979.
- 3) KISHIKAWA, M., *et al.* : Pathologic and statistic analyses of the Atomic Bomb survivors within 2Km. from the hypocenter in Nagasaki. *J. Hiroshima Med. Ass.* 31 : 405—411, 1978 (*in Japanese*).
- 4) MATSUKUMA, G. : Epidemiological, clinical and pathological studies on liver cirrhosis in Nagasaki. *Nagasaki Med. J.* 42 : 91—114, 1967 (*in Japanese*).
- 5) MIYAZAKI, J., *et al.* : Multiple primary malignant tumors of the Atomic Bomb survivors in Nagasaki —Study of autopsy cases—. *J. Hiroshima Med. Ass.* 33 : 298—305, 1980 (*in Japanese*).
- 6) NISHIMORI, I., *et al.* : Pathological study on the hepatic lesions of Atomic Bomb survivors in Nagasaki. *Nagasaki Med. J.* 47 : 319—323, 1972 (*in Japanese*).
- 7) OHASHI, S., *et al.* : Pathological findings in the fatal cases (the late Mr. Kuboyama) of the radiation sickness caused by Bikini Ashes (An intermediate report). *Iryo* 9 : 46—55, 1955 (*in Japanese*).
- 8) THE JAPANESE PATHOLOGICAL SOCIETY (ed.) : Annual of the pathological autopsy cases in Japan. Vol. 20. The Japanese Pathological Society, Tokyo, 1978 (*in Japanese*).