Heart Disease Deaths in a Japanese Urban Area Evaluated by Clinical and Police Records

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Background By national statistics, Japanese ischemic heart disease (IHD) mortality is one of the lowest of all industrialized countries, and the proportion of deaths due to heart failure in heart disease is the highest. There may be a difference in diagnostic preference between Japan and other industrialized countries.

Methods and Results IHD deaths according to the death certificates were reevaluated with World Health Organization MONICA criteria for those 25 to 74 years old by use of clinical and police records in a Japanese city with a population of 347,000. Their cause of death was given on the death certificates as IHD (International Classification of Diseases [ICD], ninth revision, codes 410-414), heart failure (428), or other heart diseases (393-405, 415-427, 429) in 1984 through 1986. Some deaths in 1985 through 1986 from stroke (430-438) or other diseases (250, 272, 278, 440-448, 797-799) were added.

The incidence and mortality for ischemic heart disease (IHD) in Japan seem to be among the lowest of all industrialized countries.1-4 As in most other developed nations, IHD mortality in Japan has been decreasing gradually since about 1970.1,2,4-11 However, nearly half of the deaths caused by heart disease in Japan involve heart failure (in the ninth revision of the International Classification of Diseases [ICD], code 428) as an underlying cause of death and are therefore not classified as being related to IHD.12 The age-adjusted mortality for heart failure has increased in the past 20 years in Japan.9 Both of these phenomena are different from any other developed countries, but details of the clinical features of heart failure in Japan have never been surveyed epidemiologically.13 Many cases of IHD may be included. Also, in Japan, some cases of sudden death may be diagnosed as cerebrovascular diseases and so recorded on the death certificates when the diagnosis of IHD might be made in Western countries. The mortalities for various diseases, especially cardiovascular diseases such as IHD and stroke, are no doubt affected by the diagnostic customs.14-24

Of 409 subjects, 397 (97%) could be examined. Reevaluation of the 106 deaths originally diagnosed as IHD yielded 73 IHDs and 11 sudden deaths of unknown origin (SD), and reevaluation of 160 deaths originally called heart failure yielded 26 IHDs and 50 SDs. In total, reevaluation of all 397 deaths yielded 101 IHDs and 69 SDs. Some 88% of SD cases were originally certified as heart failure (72%) or IHD (16%). Only two SDs were originally certified as stroke.

Conclusions Assuming that 30% of SDs were due to IHD, the number of IHD deaths would be 122, which is 11% larger than the number of IHD deaths according to the death certificates. After reevaluation, the IHD mortality in this study area still was the lowest in the industrialized countries.

Key Words ischemia • heart diseases • heart failure • death, sudden

We reevaluated deaths in a Japanese urban population in which the underlying cause of death decided from the death certificate was heart disease, stroke, or other diseases that might include IHD.

Methods

Subject Selection

The subjects of this study were all residents of Suita City who died in 1984 through 1986 of heart disease or 1985 through 1986 of strokes or the other diseases listed below. Suita, with a population of 347,000 in 1985, is in the Osaka area, which is the second largest urban area in Japan. Subjects 25 to 74 years old for whom the underlying cause of death as decided from the information on the death certificate by the Ministry of Health and Welfare was heart disease (ICD codes 393-398, 401-405, and 410-429), stroke (430-438), diabetes mellitus (250), hyperlipidemia (272), obesity (278), arterial or capillary disease (440-448), or ill-defined or unknown cause (797-799) were studied. All such subjects were selected except for stroke death, of which a subset was selected.

Items Examined

The underlying cause of death was evaluated on the basis of clinical and police records. First, we examined the case list, on which the underlying cause of death can be found for every death of city residents, and sought death certificates based on findings made there; both were obtained at the local municipality health center. After that, for all subjects whose death certificates could be obtained, we visited the hospital or private physician named on the death certificate, examined medical records, and also made an effort to interview the physician who signed the death certificate. The clinical course was studied to find whether there were phenomena suggesting IHD attacks, and for sudden deaths, whether there were witnesses of the onset of symptoms. The main items of information collected were ECGs before and after onset;
symptoms; serum levels of creatine kinase (including the MB form), lactate dehydrogenase, aspartate aminotransferase, and hydroxybutyrate dehydrogenase; and a history of previous disease (mainly of IHD). In addition, findings from other examinations such as coronary angiograms, ultrasonic echocardiograms, autopsies, etc., were collected when available. For deaths reported to the police (persons not seen by a physician in the 24 hours preceding death), we interviewed police physicians and examined police records for a history of previous disease and of the disease that ended in death. Such records include detailed reports on the circumstances of the death, including symptoms and the presence of witnesses of the death.

Categorization of Subjects After Evaluation of Underlying Cause of Death

After the collection of data, the subjects were assigned to one of the following 10 categories: (1) definite acute myocardial infarction (AMI); 2, possible AMI; 3, other IHD such as ischemic arrhythmia or congestive heart failure arising from earlier myocardial infarction; 4, heart failure with clinically manifest heart failure signs without any disease considered to be its cause; 5, heart disease other than IHD or heart failure, including valvular heart disease, arrhythmia, cardiomyopathy, etc.; 6, sudden death of unknown origin; 7, stroke; 8, death in which a disease other than heart disease or stroke was suspected as the underlying cause; 9, death for which a considerable amount of information was available, but the cause of the death, which was not sudden, could not be clearly specified; and 10, death for which the cause could not be specified because of lack of information. The categorization of definite or possible AMI was based on World Health Organization (WHO) MONICA criteria. Sudden death was defined as a death within 24 hours of the onset of acute symptoms without reports of "typical" or "atypical" chest pain (definitions of typical and atypical are found in Reference 25) and without clear signs suggesting what disease was the cause.

Two or three examiners and physicians reviewed all the data collected and independently classified the cause of each death. Any differences in their diagnoses were then adjudicated by the examiners and physicians, who reviewed the case together and agreed on a final diagnosis.

Examinations were done generally in the year after the death except for cases of stroke, those who died far from the city, and those whose death certificates were not obtained soon after death. Stroke cases were reviewed in 1989, and all examinations were finished by the end of 1990.

Stroke Cases: Subject Selection, Items Examined, and Categorization Criteria After Examination

Since the number of deaths with stroke as the underlying cause was large, we selected only those subjects in the following categories: (1) those whose death certificate mentioned heart disease as well as stroke, (2) those who died 24 hours or less after the onset of stroke, (3) those who died at least 1 year after the onset of stroke, (4) those whose death certificates were issued by private or police physicians, and (5) 10% (randomly sampled) of the remaining patients who died in a hospital more than 24 hours after the onset of stroke but less than 1 year after. We chose the subjects in categories 1 through 4 because in category 1, heart disease is mentioned on the death certificates, so heart disease might be a major contributory cause of death. In categories 2 and 4, computed tomography (CT) might not be done, and in category 3, the time between the onset of stroke and death was long, and other diseases such as IHD might be a contributory cause of death. All other subjects who died of stroke were likely to be examined by CT before death, because they died in the hospital and there was time enough for such examination after the onset of stroke. In fact, almost all hospitals in this area have CT scanners, and 99% of the patients reported by hospitals to the stroke registry of Suita City have had CT examinations.

In addition to the items already mentioned for the case of heart disease, neurological findings and findings of brain CT scans were examined. Our judgment was stroke if there were definite CT findings or neurological findings such as the development of paralysis, sensory disturbances, dysarthria, or other neurological focal signs. If such findings were not recorded, lowering of the level of consciousness before a lowering of blood pressure or the onset of heart failure was also taken to suggest stroke.

Numbers of Subjects in Different ICD Categories for Underlying Cause of Death and by Place of Death and Origin of Death Certificate

In Suita City, the total number of deaths in 1984 through 1986 of residents 25 to 74 years old was 2066. The number of deaths caused by heart disease, according to death certificates, was 323, with 80 (25%) involving AMI (ICD code 410), 30 (9%) involving other kinds of IHD (411-414), 164 (51%) involving heart failure (428), and 49 (15%) involving valvular, hypertensive, or other heart disease (393-405, 415-427, 429). In total, 153 deaths caused by stroke were recorded in 1985 and 1986, and 67 were selected among these: 21 subjects in category 1; 27 in category 2, of whom 8 were seen by their private clinicians only and of whom the others died in hospital; 7 in category 3; 3 in category 4; and 9 in category 5. Nineteen deaths were caused by diseases other than heart disease or stroke in 1985 and 1986: 11 involving diabetes mellitus (250), 1 involving arterial disease (440), and 7 involving ill-defined or unknown causes (797-799). No deaths were ascribed to hyperlipidemia (272) or obesity (278). A total of 409 deaths were selected for examination on the basis of the list of underlying causes of death. Of these, one death certificate could not be obtained at the health center (Table 1).

In all, 266 of the selected subjects died in Suita City, 68 died nearby in the northern part of Osaka Prefecture, 38 died in Osaka City, 15 died elsewhere in Osaka Prefecture, and 27 died outside of Osaka Prefecture. The death certificates were issued by hospitals with ICD-9 codes for cardiovascular diseases in 70 cases, by other hospitals in 219 cases, by private clinicians in 38 cases, and by police physicians in 81 cases. For the remaining 1 case, the origin of the death certificate, which was not obtained, was unknown.

Results

Subjects Successfully Examined and Details of Data Sources Examined for Each Subject

We could examine 397 subjects (97%). Of 316 non-police cases, the medical records for the disease that ended in death were obtained for 312 cases (99%), and for 77 cases (24%), medical records of previous diseases were also obtained. Three cases were examined only by a meeting with the physicians who signed the death certificates, and for the remaining 1 case, only the medical record for the earlier disease was available. Of 81 police cases, police physicians were interviewed for all cases, and for 76 cases (94%), police records could also be examined. Of the 12 subjects who could not be examined, in 7 cases the facility that issued the death certificate refused permission for it to be examined for reasons of privacy; the facility was too far to visit in 3 cases; the medical records could not be found for 1 case; and the death certificate was not obtained for 1 case.

Findings of Heart Disease After Reevaluation

Of 80 subjects with AMI as the underlying cause of death as judged from the death certificate, 76 (95%)
were known to have experienced some kind of acute change within 28 days before death. These numbers were 14 (47%) of 30 for other IHD cases, 99 (60%) of 164 for the cases of heart failure, and 28 (57%) of 49 for the cases of other heart disease.

Of those who experienced some kind of acute change, for AMI cases, the rate of availability of records about symptoms of the attacks was 75% (57 of 76), the rate of ECGs was 65% (48), and that of enzymes was 51% (44). Other records of ultrasonic echocardiograms, coronary angiograms, and autopsy were obtained only at the low rates of 9% (7), 14% (11), and 7% (5), respectively. For other categories of diseases, these rates were generally lower except for ultrasonic echocardiograms and autopsy; ie, 29% to 54% for symptoms, 15% to 50% for ECG, 15% to 31% for serum enzymes, 0% to 21% for ultrasonic echocardiograms, 0% to 7% for coronary angiograms, and 4% to 21% for autopsy.

**Findings of Stroke Cases After Reevaluation**

In 63 of 67 stroke cases, medical records could be examined; 39 subjects (62%) had CT examinations, and 38 subjects (60%) had CT findings that indicated stroke. Including those subjects with positive neurological findings suggesting stroke but with no positive CT findings or CT examinations, a total of 56 deaths (89%) were attributed to stroke.

On reevaluation, only 3 deaths seemed likely to be caused by heart disease or sudden death. In another 3 deaths, there was the possibility of heart disease, including 1 case of possible AMI, but there was evidence of cerebrovascular attacks also, so the underlying cause of death for those 3 cases could be cerebrovascular disease. As we expected, all 9 of the cases sampled randomly from those who died more than 1 day but less than 1 year after onset had CT examinations and findings indicative of stroke.

**Findings of Other Disease Cases After Reevaluation**

There were 19 cases included in the category of "other diseases." After reevaluation, no deaths were seen to be due to definite or possible AMI, other IHD, or sudden death.

**Relation of Codes for Underlying Cause of Death on the Death Certificate and Categorization After Reevaluation**

According to the death certificates, 110 patients died of IHD, 164 of heart failure, 49 of other heart disease, and 86 of other diseases. After reevaluation, there were 101 IHD deaths and 69 sudden death cases of unknown origin. This indicates that the estimated number of deaths caused by IHD in this study is 101 at the minimum and 170 at the maximum (Table 2).

Among 80 AMI cases from the death certificate base, after reevaluation, there were 31 cases (39%) of definite AMI, 27 cases (34%) of possible AMI, and 9 cases (11%) of sudden death. Of the subjects with "other IHD" as the cause of death before reevaluation, these numbers were 2 (7%), 9 (30%), and 2 (7%), respectively, after reevaluation. The 164 deaths originally ascribed to heart failure were categorized after reevaluation into four major categories: 26 deaths caused by IHD (16%), 50 sudden death cases (30%), 47 deaths (29%) that were proved not to be caused by heart disease or had no findings suggesting heart disease as an underlying cause of death, and 27 deaths (16%) in which information was lacking for reevaluation. In all, 90% of all subjects with heart failure as decided from the death certificate fit into one of these four categories.

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**Table 1. Number of Subjects Selected for Examination Classified by ICD Code* for Cause of Death in Each Age Group**

<table>
<thead>
<tr>
<th>ICD Code*</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>393-405</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>410</td>
<td>1</td>
<td>6</td>
<td>11</td>
<td>20</td>
<td>42</td>
<td>80</td>
</tr>
<tr>
<td>411-414</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>415-427</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>428</td>
<td>7</td>
<td>15</td>
<td>22</td>
<td>38</td>
<td>82</td>
<td>164</td>
</tr>
<tr>
<td>429</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Stroke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>430-438</td>
<td>0</td>
<td>3</td>
<td>16</td>
<td>11</td>
<td>37</td>
<td>67</td>
</tr>
<tr>
<td>Other diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>440</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>797-799</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>29</td>
<td>66</td>
<td>91</td>
<td>213</td>
<td>409</td>
</tr>
</tbody>
</table>


* Ninth revision of International Classification of Diseases, Injuries and Cause of Death.12
Table 2. Cross-Tabulation of Underlying Cause of Death Decided From Death Certificates and Decided by Reevaluation

<table>
<thead>
<tr>
<th>Categorization After Reevaluation</th>
<th>Number of Deaths Classified by Selected ICD Codes on Death Certificate</th>
<th>Heart Disease</th>
<th>Other Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AMI</td>
<td>Other IHD</td>
<td>HF</td>
</tr>
<tr>
<td>Definite AMI (410)</td>
<td>31</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Possible AMI (410)</td>
<td>27</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Other IHD (411-414)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>HF (428)</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Other heart disease (393-405)</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>(415-427) (429)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sudden death of unknown origin</td>
<td>9</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Stroke (430-438)</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Other disease*</td>
<td>5</td>
<td>1</td>
<td>38</td>
</tr>
<tr>
<td>Cause of death not specified</td>
<td>3</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Lack of information</td>
<td>0</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>Not examined</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Total in small category</td>
<td>80</td>
<td>30</td>
<td>164</td>
</tr>
<tr>
<td>Total in large category</td>
<td>110</td>
<td>164</td>
<td>49</td>
</tr>
</tbody>
</table>

AMI indicates acute myocardial infarction; IHD, ischemic heart disease; and HF, heart failure. Numbers in parentheses are the codes of the ninth revision of International Classification of Diseases, Injuries and Cause of Death (ICD).12

*Other than heart disease, stroke, or sudden death.

Only 3 deaths were classified during reevaluation as being caused by isolated heart failure.

There were 49 other heart disease deaths on the death certificates (ICD codes 393-405, 415-427, 429). Reevaluation yielded 1 case of definite AMI, 1 case of possible AMI, and 6 cases of sudden death. There were no other cases of IHD. Only a few cases were categorized as IHD or sudden death after reevaluation that were described as other than heart disease on the death certificates.

Of 101 cases of IHD found by reevaluation, 73 deaths (72%) were originally coded as IHD (ICD 410-414) and 26 (26%) were coded as heart failure (ICD 428) as the underlying cause of death on the death certificate, and summing these numbers yielded 98%. Similarly, of 69 cases of sudden death found by reevaluation, 50 (72%) were coded as heart failure and 11 (16%) as IHD as the underlying cause of death. Summing these numbers yielded 88%.

Availability Rates and Findings of the Records Obtained for Cases Categorized as Definite or Possible AMI or Sudden Death After Reevaluation

For the cases reevaluated as being definite AMI, the rates of availability of records were 93% for symptoms, 98% for ECG, and 95% for serum enzymes. For the cases reevaluated as possible AMI, most commonly obtained information useful for categorization was of typical or atypical symptoms (59%) and history of previous IHD (51%). The rates of availability of records, especially ECG (39%) and data on serum enzymes (25%), were lower for possible AMI cases than for definite AMI. For the cases of sudden death, information was scarcely available for any item; ie, 13% for symptoms and 9% for both ECG and enzymes.

Relation of Descriptions on the Death Certificate and Categorization After Reevaluation for Cases of Heart Failure (ICD 428) as Decided From the Death Certificate

For those whose cause of death was coded as ICD 428 as decided from death certificates, three phrases were used on the death certificates: "acute heart failure," "heart failure," and "acute cardiac arrest." Most of the subjects had one of the first two phrases: "acute heart failure" for 113 (69%) and "heart failure" for 45 (27%); only 6 (4%) had "acute cardiac arrest."

Some 82 (73%) of the 113 subjects with "acute heart failure" died within 24 hours of onset according to the death certificate, and 75 subjects (66%) were known to have had some kind of acute change before death. This category included 44 cases of sudden death and 15 cases of IHD after reevaluation. For 21 cases, information was lacking. This included a number of subjects found long after death.

Of the 45 subjects with "heart failure" written on the death certificate, 28 (62%) were described on the death certificate as having died more than 24 hours after onset, and after reevaluation, 26 subjects (58%) were not recorded as having had any kind of acute change before death, and 20 cases of "heart failure" (44%) were recategorized as diseases other than heart disease. Many deaths from "heart failure" were found on reevaluation to involve generalized weakness after long-term confinement to bed because of chronic disease in elderly subjects, and only 3 sudden death cases and 9 IHD...
TABLE 3. Death Rates Standardized for Age and Sex for Heart Disease in Suita and Several Industrialized Countries for Age 25 to 74 Years in 1984 Through 1986

<table>
<thead>
<tr>
<th>Disease</th>
<th>ICD Code</th>
<th>Suita</th>
<th>Japan</th>
<th>USA</th>
<th>Canada</th>
<th>France</th>
<th>West Germany</th>
<th>England, Wales</th>
<th>Hungary</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>All causes of death</td>
<td>(393-429)</td>
<td>420.6</td>
<td>485.7</td>
<td>734.9</td>
<td>630.0</td>
<td>649.3</td>
<td>690.3</td>
<td>732.3</td>
<td>1154.1</td>
<td>638.1</td>
</tr>
<tr>
<td>Heart disease</td>
<td>(393-429)</td>
<td>72.0</td>
<td>78.8</td>
<td>245.3</td>
<td>193.9</td>
<td>110.6</td>
<td>204.5</td>
<td>247.2</td>
<td>305.8</td>
<td>209.7</td>
</tr>
<tr>
<td>AMI (410)</td>
<td></td>
<td>18.3</td>
<td>20.7</td>
<td>102.8</td>
<td>107.6</td>
<td>50.4</td>
<td>101.3</td>
<td>155.6</td>
<td>145.3</td>
<td>132.8</td>
</tr>
<tr>
<td>Other IHD (411-414)</td>
<td></td>
<td>7.4</td>
<td>7.3</td>
<td>68.0</td>
<td>54.8</td>
<td>14.1</td>
<td>37.8</td>
<td>65.9</td>
<td>78.4</td>
<td>47.7</td>
</tr>
<tr>
<td>Total of IHD (410-414)</td>
<td></td>
<td>25.7</td>
<td>28.0</td>
<td>170.8</td>
<td>162.4</td>
<td>64.5</td>
<td>139.1</td>
<td>221.5</td>
<td>223.7</td>
<td>180.5</td>
</tr>
<tr>
<td>Other heart diseases (393-405, 415-429)</td>
<td>46.3</td>
<td>50.8</td>
<td>74.5</td>
<td>31.5</td>
<td>46.1</td>
<td>65.4</td>
<td>25.7</td>
<td>82.1</td>
<td>29.2</td>
<td></td>
</tr>
</tbody>
</table>

ICD indicates International Classification of Diseases, Injuries and Cause of Death; AMI, acute myocardial infarction; and IHD, ischemic heart disease.

Figures are deaths per 100,000 calculated from the World Health Statistics Annual and Japanese annual vital statistics. The standard population used is the population of Japan in 1985.

Deaths were referred to as “heart failure” on the death certificates.

Of the 6 subjects described as having had “sudden cardiac arrest,” 5 experienced acute changes before death, and of these, the cause of death was found during reevaluation to be possible AMI for 2 and sudden death for 3.

As a result, for the heart failure cases, most of those who after reevaluation were recategorized into sudden death or IHD were originally diagnosed as “acute heart failure” on the death certificate.

**Discussion**

As a result of the present study, the number of deaths caused by ischemic heart disease was estimated to be between 101 and 170, if the criteria we used were accurate to estimate the actual number and all IHD cases are included in the reevaluated categories of IHD or sudden death. The actual number of IHD deaths depends on how many IHDs were included in sudden death cases. Since autopsies were not commonly done in our study population, it is difficult to know how many of the sudden deaths can be considered as caused by IHD. However, in several big cities of Japan, sudden death cases are routinely investigated by autopsy if the deaths are reported to the police; our city is located just north of Osaka city and belongs to the Osaka urban area, so the details of sudden death cases are similar to the case in such big cities. From a report in Tokyo, which is one of those cities, in 1980, 47% of clinically diagnosed sudden deaths were due to heart disease, and 30% were due to coronary atherosclerosis. The reported rates of IHD included in sudden death cases in Western countries are different: 60% for heart disease and 54% for coronary atherosclerosis in Hamburg, Germany, and 61% for coronary artery disease in New York State.

The autopsied subjects in Tokyo were limited to police cases, but the definition of sudden death in that report is similar to that of sudden death in our study. In fact, more than half of those who were reevaluated as sudden death in our survey were police cases, and it seems reasonable to apply the Tokyo sudden death data to our survey. If we impose the findings from Tokyo autopsies on our results, taking 30% of the sudden death cases in our subjects to be due to IHD, the estimated number of deaths due to IHD becomes 122, which is 11% larger than the number of deaths due to IHD according to the death certificates.

We calculated mortality from heart disease standardized for age and sex in certain industrialized countries, for all of Japan, and for the Suita area based on the World Health Statistics Annual and Japanese annual vital statistics (Table 3). The death rate due to IHD standardized for age becomes 28.3 per 100,000 in the Suita area using the present results; this figure is only 11% larger than that calculated from death certificates (Table 3). Thus, the death rate due to IHD estimated here is still by far the lowest in the industrialized countries.

We calculated age- and sex-standardized trends of mortality for IHD, heart failure, and heart disease in 1979 through 1990 with the Japanese vital statistics, and we also calculated “corrected” IHD mortality, imposing our results and Tokyo autopsy data on the vital statistics data (Figure). In this figure, we can see declining trends of mortality for both IHD and heart disease and a rising trend of heart failure mortality. After the correction, the declining trend of IHD mortality does not change, but its slope becomes less steep compared with the uncorrected one.

The possibilities were considered that IHD cases might be included in the categories of “cause of death not specified” and “lack of information” after reevaluation and the cases not examined. For most of those reevaluated as “cause of death not specified,” the clinical course toward death was generalized weakness gradually worsening, with the subject usually having several serious diseases concurrently, so simple disease was difficult to specify as an underlying cause of death. However, no heart attack apparently existed in any case in this category, and it was not plausible to include any IHD cases. Of 40 cases reevaluated as “lack of information,” most subjects were found dead with almost no information about the death or previous diseases, so the proportion of IHD included in this category is hard to estimate. However, it would be considerably less than that in those reevaluated as sudden death, because many cases without acute change must be included in this category. Since only 30% were estimated as IHD even in sudden death cases, at most a few IHD cases
could be included in this category. For 12 cases not examined, the underlying causes of death based on death certificates were AMI for 1 case, IHD for 3, heart failure for 4, and stroke for 4. If we impose on these cases the rates of IHD cases included in these categories for the cases examined in the present study, the estimated number of IHD deaths becomes 3. Summing the numbers stated above, the number of IHD cases included in these three categories would be \( \approx 10 \) at most. However, even the largest estimation would be small and would have no substantial effect on the present results.

We expected that some number of deaths due to IHD or sudden death had been misclassified on the death certificate as being due to stroke. However, only three such cases were found (two were reclassified as sudden death and one as "other heart disease"). None of the deaths described on death certificates as being due to diabetes mellitus, etc., were found to be due to heart disease after reevaluation. Not all cases of stroke were examined, but the subjects omitted were all hospitalized, and the time until death after the onset of stroke was between 1 day and 1 year. Thus, to judge from registry system data, all were likely to have had CT done (in fact, all nine cases randomly selected from this category had had CT examination), so deaths due to heart disease but described as stroke on the death certificate appeared to be very few. In fact, the CT examination is precise in identifying cerebrovascular diseases, and it was shown by Iso et al.\(^{22}\) that stroke diagnosis using CT scan is generally valid.

This is the first population-based study in Japan reevaluating the heart failure cases decided from death certificates by examining medical and police records. As a result of this study, we found various disease conditions under the name of heart failure (Table 2). Heart failure cases could mainly be divided into the four categories of sudden death, IHD, diseases other than heart disease, and the cases without enough information to make a diagnosis. Most of the sudden death cases were included in heart failure. However, only three cases were classified as being due to isolated heart failure after the reevaluation. Therefore, it seems that most of the heart failure that appears in Japanese vital statistics cannot be considered to be "pure" heart failure.

This study included urban residents only, so similar examinations of other populations would be necessary to see whether this phenomenon is generalizable to other areas of Japan. A study similar to ours was done to examine deaths in 1988 and 1989 in Oita City (population 420,000), Kyushu, where IHD mortality is higher than in most other areas in Japan, but in that study police records were not examined and stroke cases were excluded from examination.\(^{33}\) The proportions of deaths due to IHD and heart failure among all deaths arising from heart disease are similar in both studies, and reevaluation of IHD gave similar results. Exceptions are that in the Oita study, the proportion of reevaluated sudden death in death certificate heart failure was 50\%, much larger than in Suita, and the proportion of IHD in death certificate heart failure was only 2\% after reevaluation, much smaller than the value in Suita. However, when the percentages of deaths due to these two causes are summed, the figure becomes similar in the two populations. The reason for this phenomenon seems to be not a difference in diagnostic custom but rather the fact that information from the police was not obtained in the Oita study.

We inspected medical records and saw the physicians who signed the death certificates by visiting every facility that issued the death certificates in question; we also examined police data, which were often very useful for the evaluation of deaths (50\% of sudden death cases and 15\% of cases of possible AMI were police cases). Thus, the information we obtained was assumed to be similar to what the physicians knew when they made out the death certificates. This kind of survey reevaluating population-based heart disease death had scarcely been done before in Japan. We also used the criteria of the WHO MONICA protocol, which is widely used to identify AMI cases in epidemiological studies. Therefore, the results obtained in this survey can offer data comparable to other surveys of this kind in other countries. The present results showed that IHD mortality in our study population was very low for an industrialized country.

**Acknowledgments**

This study was supported in part by research grant 63 A-3 for cardiovascular diseases from the Japanese Ministry of Health and Welfare. We thank Dr Hidetoshi Matsuyama, the former chairman of the Medical Association of Suita City, for...
his cooperation and good advice to this survey. (Dr. Matsu-
yama died suddenly of a heart attack in December 1989.) We
also express our appreciation to Etsuko Santo for her contin-
uous secretarial support and Caroline Latta for her careful
assistance in editing the manuscript.

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Heart disease deaths in a Japanese urban area evaluated by clinical and police records.
S Baba, H Ozawa, Y Sakai, A Terao, M Konishi and K Tatara

_Circulation_. 1994;89:109-115
doi: 10.1161/01.CIR.89.1.109

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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