

## REVIEW ARTICLE

Akira Oshima · Wakiko Ajiki · Hideo Tanaka  
Hideaki Tsukuma

## Significance and usefulness of cancer registries

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### Abstract

A cancer registry is an organization set up for the collection, storage, analysis, and interpretation of data on people with cancer. There are three types of cancer registry: hospital-based, population-based, and nationwide site-specific. A cancer registry is essential for planning and evaluating cancer control activities, including clinical practices. We describe the significance and usefulness of cancer registries, with examples of assessments of the size of the cancer problem (i.e., incidence, mortality rates, and survival of cancer patients), assessments of the effects of cancer control programs, feedback to clinicians, and the building and testing of hypotheses of cancer etiology.

**Key words** Cancer registry · Population-based · Hospital-based · Site-specific · Cancer control

### Introduction

A cancer registry is a system that is essential for planning and evaluating cancer control activities, including clinical practices. Our main purpose in this article is to highlight the significance and usefulness of cancer registries for clinicians in the field of cancer practice. We hope this will be helpful not only for interesting clinicians in the use of cancer registry data but also for prompting clinicians to participate more positively in cancer registration activities. For this purpose, we provide a targeted review, giving examples of the uses of cancer registry data, rather than providing a systemic review. The role of registries in cancer control was reviewed systematically in a monograph pub-

lished by the International Agency for Research on Cancer (IARC) in 1985.<sup>1</sup>

### Types of cancer registries

A cancer registry can be defined as an organization for the collection, storage, analysis, and interpretation of data on people with cancer. There are three types of cancer registry: (1) hospital-based cancer registries, which undertake these tasks within the confines of a hospital; (2) population-based cancer registries, which are concerned with all newly-diagnosed cases of cancer occurring in a well defined population; and (3) nationwide site-specific cancer registries, which are administered by study groups interested in a specific site of cancer, and collect detailed information on diagnosis and treatment. Therefore, those hospitals that participate in site-specific registries are usually large institutions.

Of these three types of cancer registries, only the population-based cancer registry can provide two types of useful and unbiased information on cancer patients in a defined population (i.e., cancer incidence rates and survival of cancer patients) which are essential for planning and evaluating cancer control activities.

### Population-based cancer registries

History of population-based cancer registries: World wide and in Japan

The first population-based cancer registries in the world were set up shortly before and during the Second World War – in Connecticut, in the United States in 1936, in the province of Saskatchewan in Canada in 1944, in Denmark in 1942, and in south-western regions of the United Kingdom in 1945. Population-based cancer registries have since been established in many countries and regions not only in

A. Oshima (✉) · W. Ajiki · H. Tanaka · H. Tsukuma  
Department of Cancer Control and Statistics, Osaka Medical  
Center for Cancer and Cardiovascular Diseases, 1-3-3 Nakamichi,  
Higashinari-ku, Osaka 537-8511, Japan  
Tel. +81-6-972-1181 (ext. 2301); Fax +81-6-978-2821  
e-mail: xoosima@iph.pref.osaka.jp

North America and Europe but also in Oceania, Central and South America, Asia and Africa.

The International Association of Cancer Registries (IACR) was founded in 1966 to coordinate and supervise the content and methods of data collection on cancer patients for international comparisons of cancer morbidity. Since then, a monograph *Cancer Incidence in Five Continents (CI5)* has been published regularly under the close collaboration of the IARC and the IACR to provide comparable data on the incidence of cancer in different geographical locations and distinct ethnic sub-populations in these locations. Volume VII of CI5,<sup>2</sup> published in 1997, presented data on cancer incidence in the period 1988–1992 for 183 populations in 50 countries from 150 registries.

Population-based cancer registries in Japan were first established in Hiroshima city in 1957 and in Nagasaki city in 1958 for studying the long-term effects of atomic bomb radiation. In 1959 the Miyagi Tumor Registry was started by the Department of Public Health, Tohoku University Medical School, to assess cancer risk in Miyagi Prefecture. Cancer registration schemes as part of prefectural cancer control programs were first provided in 1962 by the Health Departments of Aichi Prefecture and of Osaka Prefecture. Subsequently, this type of cancer registry has gradually spread throughout in Japan.

In 1975, the Research Group for Population-based Cancer Registration in Japan was organized supported by a Grant-in-Aid for Cancer Research from the Ministry of Health and Welfare of Japan. Since then, continuous efforts have been made by the Research Group to improve the quality of registry data, as well as to develop methods of utilizing these data. The Research Group also provides annual estimates of cancer incidence in the whole of Japan based on data obtained from registries that fulfill the standard requirements set by the chief researcher of the Group. The Research Group now consists of 13 registries

with active researchers and with data quality above the standard.

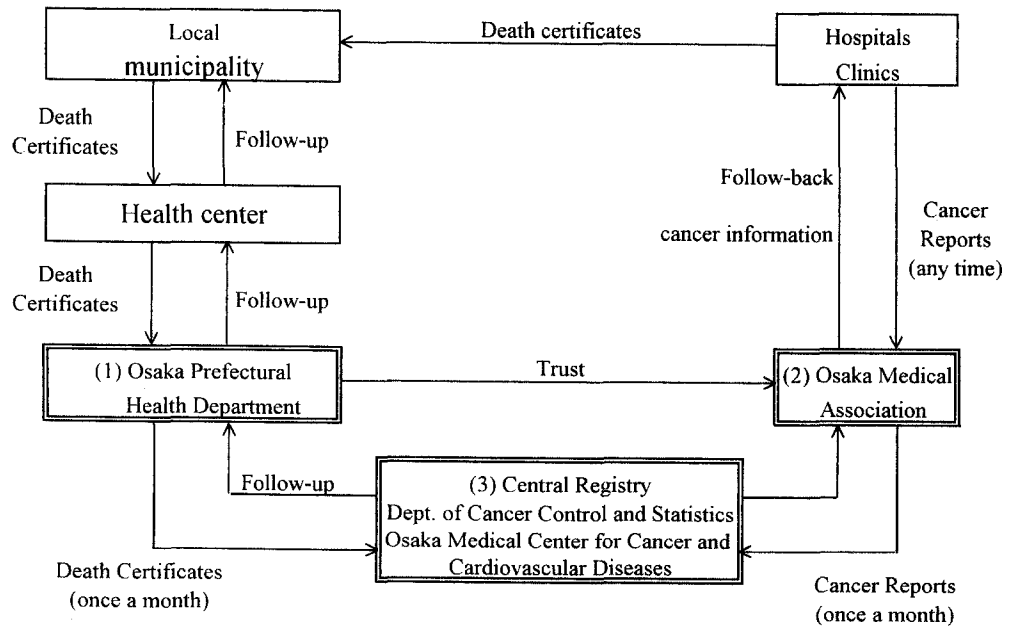
In 1992, in order to improve the quality of cancer registries in Japan, the Japanese Association of Cancer Registries was established, with 32 members, comprising the prefectural and city cancer registries existing at that time. In 1998 there are 35 members. The Association has held annual meetings and has regularly published proceedings of the meetings.

Population-based cancer registrations in Japan

According to the 1997 survey of cancer registries in Japan,<sup>3</sup> 35 population-based cancer registries were operating and they covered about 70% of the total population of Japan. Most registries are run by prefectural governments in cooperation with the prefectural medical association and the prefectural cancer centers.

Cancer registration systems vary according to prefecture. The system in Osaka is shown in Fig. 1 as an example. The Osaka Prefectural Health Department prepares a budget and the Osaka Prefectural Medical Association collects cancer reports from all medical institutions in the prefecture. The Association requests physicians and hospitals to mail cancer reports to the Association. Cancer reports are prepared by physicians or by medical record librarians in hospitals, and are sent to the Association. These cancer reports are transported once a month from the Association to the central registry. The central registry is located at the Department of Cancer Control and Statistics, Osaka Medical Center for Cancer and Cardiovascular Diseases. The Osaka Prefectural Health Department sends copies of cancer death certificates of Osaka residents to the central registry, with the permission of the Ministry of Health and Welfare. Five years after the diagnosis of cancer, the prognoses of all cancer patients who are still living (determined

Fig. 1. Osaka Cancer Registry system



by collation of information with death certificate files) are surveyed by Osaka Prefectural Health Department staff.

Cancer registration in Japan has been carried out on a voluntary basis. Cancer records are actively collected by visiting the source of data in three registries (Hiroshima City, Nagasaki City, and Miyagi Prefecture), but only passively i.e., by self-reporting from hospitals or doctors in many registries. Many cancer registries suffer from budgetary limitations and lack of trained personnel. Only a few large hospitals have medical record librarians. Under these circumstances, it is difficult to obtain high-quality cancer registry data. Thus, only cancer data from six cancer registries (Miyagi, Yamagata, Osaka, Hiroshima City, Saga, and Nagasaki) were accepted for publication in Vol. VII of CI5.

To improve the quality of population-based cancer registries in Japan, it is very important for clinicians involved in cancer practice to understand the significance and usefulness of these registries. We describe, the significance and usefulness of cancer registry data, with examples mainly from the Osaka Cancer Registry (OCR). The OCR has been operating since December 1962, and has made various efforts to provide a service to the medical profession from its inception. The OCR covers a large population (8797268 as of 1995) and its data quality has been kept at a reasonably high level for more than 30 years with the understanding and collaboration of physicians and hospitals in Osaka.

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### **Uses of cancer registries in planning cancer control activities: Assessment of the size of the cancer problem**

Three indices are used to assess the size of cancer problem: cancer mortality rate, cancer incidence, and the survival rates of cancer patients. The latter two of these indices can be assessed without any selection bias by a population-based cancer registry. The OCR has been preparing annual reports on cancer incidence and mortality since 1965. The Osaka Prefectural Health Department has published the reports and the Osaka Medical Association has distributed them to participating institutions. In 1993 the monograph *Cancer Incidence and Mortality in Osaka 1963–1989* was issued in commemoration of the 30th anniversary of the OCR.<sup>4</sup> During the period 1987–1989, the proportion of cases registered by death certificates only (DCO) as a percentage of the total incidence was 21%. The proportion of DCO cases with no supporting evidence of diagnosis, except for a clinical diagnosis on their death certificate was 15% during the same period.

The OCR has been making various efforts to estimate the survival of cancer patients since its earlier years. Since 1981, patients diagnosed with cancer after 1975 have been followed-up actively to determine whether each case is alive or dead for all cancer patients in Osaka Prefecture, excluding Osaka City after 5 and 10 years from the time of diagnosis. This is done by checking the resident registers, in cooperation with health center staff. Data on survival have been reported annually since 1983 and the monograph

*Survival of Cancer Patients in Osaka 1975–89* was published in 1998.<sup>5</sup> Fewer than 5% of cases were lost to follow-up 5 years after diagnosis during the period. Data on cancer incidence, mortality, and survival in the annual report of the OCR can now be obtained on the OCR website (<http://www.iph.pref.osaka.jp/omc/ocr/>).

Trends in cancer incidence rate in Osaka are shown in Fig. 2, and trends in survival of cancer patients are shown in Fig. 3. These figs. show that the incidence rate of stomach and cervical cancer has been decreasing, and that the incidence rate of cancers of lung, liver, pancreas, and gallbladder, which have survivals that have remained at low levels, has been increasing. Cancers of colon and breast, which are common in Western European countries and in the US, have also been increasing.

Table 1 shows the trends in the estimated numbers of incident cases for both sexes in Japan (estimated by the Research Group for Population-based Cancer Registration in Japan), together with the numbers of cancer deaths. Due to the aging of the population in Japan the estimated number of cancer incident cases for all sites has increased from 209000 in 1975 to 430300 in 1993. The incidence of cancer in 1993 – 430300 – is about 1.8 times the number of cancer deaths in the same year (235707). In 1993, the stomach was the main site of cancer (number of incident cases, 96882), followed by colon (50490), lung (48686), liver (32888), female breast (27563), and rectum (25251), in this order.

The methodology of estimating cancer incidence by the Research Group is not shown here, as it has been described in detail elsewhere.<sup>6</sup> The estimates have been reported annually in the report of the Research Group and summaries of the results have been reported in several scientific journals. The most recent estimates of cancer incidence are published in the *Japanese Journal of Clinical Oncology*<sup>7</sup> and they are also available on the OCR website.

Although current and past data on the incidence of cancer are important, future projections of cancer incidence may be much more important for cancer control planning. Several predictions have been made based on the trend of cancer incidence data.<sup>8–10</sup> The most recent prediction<sup>10</sup> indicates that: (1) the number of cancer incident cases will increase rapidly due to the aging of the Japanese population. In 2010 the number will be 2.20 times that of 1989, (2) the proportion of cancer incident cases in patients aged 70 years and over will increase, from 41% in 1989 to as much as 58% of the total cases in 2010, (3) the proportion of cancer incident cases with poor prognosis, (i.e., cancers of lung, liver, pancreas, and gallbladder) will increase from 26% in 1989 to as much as 36% in 2010. *These data clearly show that the priority of cancer control activities should shift from early detection and cure to primary prevention and care.*

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### **Uses of cancer registries in evaluating cancer control activities: Assessment of the effect of control programs**

For evaluating cancer control activities, the trends in cancer incidence and survival of cancer patients provided by a

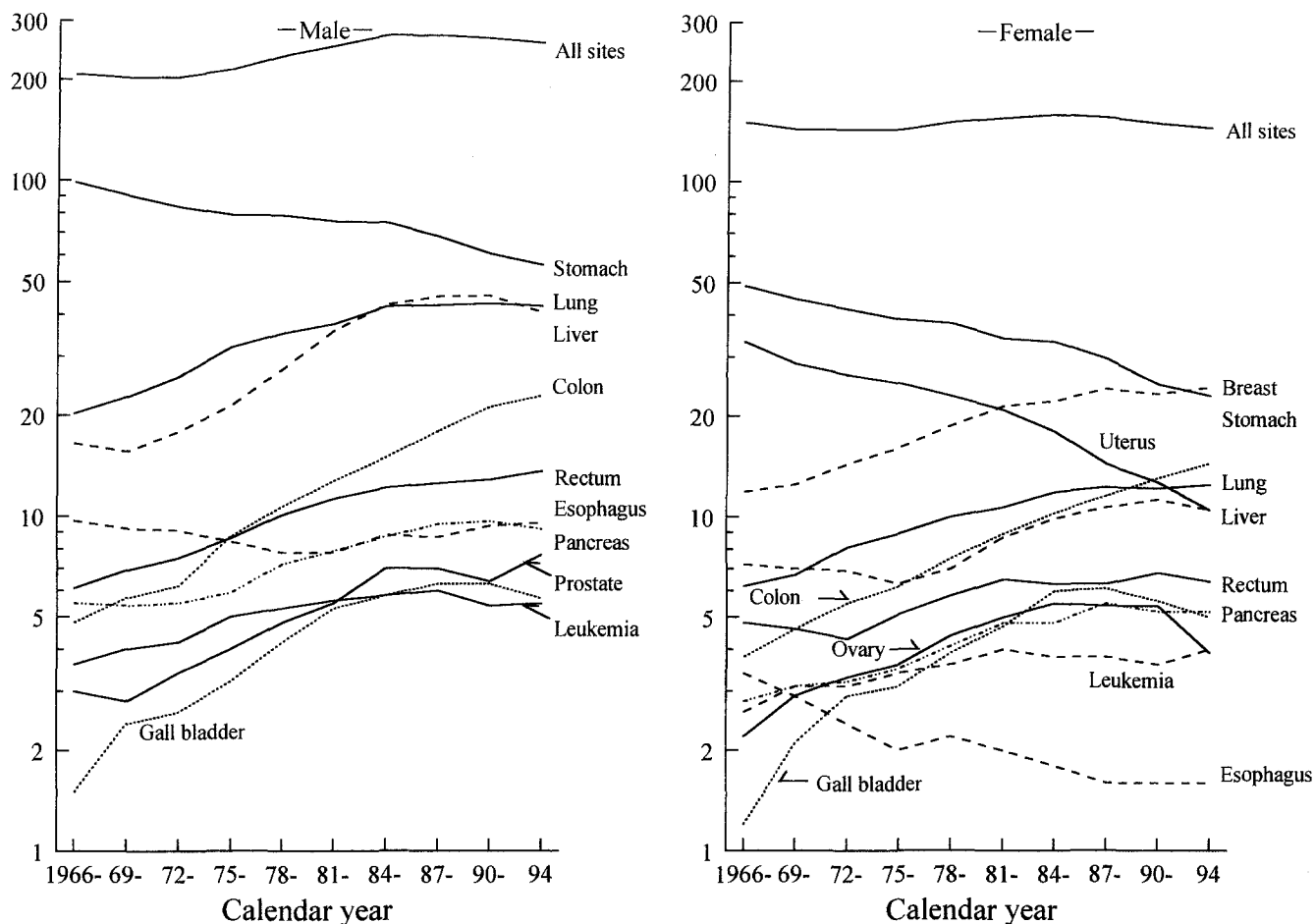


Fig. 2. Trends in age-standardized cancer incidence rates per 100000 population for major sites, by sex, in Osaka (standard population: world population)

Table 1. Trends in number of cancer incident cases and cancer deaths in Japan according to sex, primary site, and calendar year, for both sexes

Site	1975		1985		1993	
	Incident cases	Cancer deaths	Incident cases	Cancer deaths	Incident cases	Cancer deaths
All sites <sup>a</sup>	208 931	136 383	335 711	187 714	430 299	235 707
All sites <sup>b</sup>	206 702	136 383	331 485	187 714	424 900	235 707
Esophagus	5 761	4 997	8 349	6 197	11 167	8 040
Stomach	75 133	49 857	95 078	48 902	96 882	47 311
Colon	9 062	5 573	23 200	11 225	50 490	18 098
Rectum	9 110	5 904	16 621	7 934	25 251	9 963
Liver	10 835	10 588	23 547	19 871	32 888	27 765
Pancreas	6 075	5 635	11 497	10 441	15 669	14 713
Lung	17 672	14 759	36 773	28 590	48 686	41 527
Female breast	11 123	3 262	20 296	4 922	27 563	6 758
Uterus <sup>a</sup>	16 397	6 075	17 623	4 912	17 498	4 445
Uterus <sup>b</sup>	14 176	6 075	13 685	4 912	12 469	4 445

<sup>a</sup>Including carcinoma in situ.

<sup>b</sup>Excluding carcinoma in situ.

population-based cancer registry are very useful, together with trends in cancer mortality rates obtained from mortality statistics. Generally speaking, a decrease in cancer incidence shows the effect of primary prevention measures, and

an improvement in survival of cancer patients shows the effects of secondary prevention and treatment, while a decrease in cancer mortality rates shows the effect of cancer control activities overall.

When there are only mortality statistics data and they show that cancer mortality rates have been decreasing, we cannot differentiate the effect of primary prevention from that of secondary prevention and treatment. Fig. 4 shows the trends in age-standardized stomach cancer incidence

and mortality rates from the OCR. The mortality rate declined almost in parallel with the incidence rate in the 1960s. After the 1970s, however, the gap between the incidence and the mortality rate has become wider. These data show that the decline in the mortality rate for stomach cancer in Japan is due mainly to factors such as changes in dietary habits, and that it can be explained partly by efforts made in early detection.

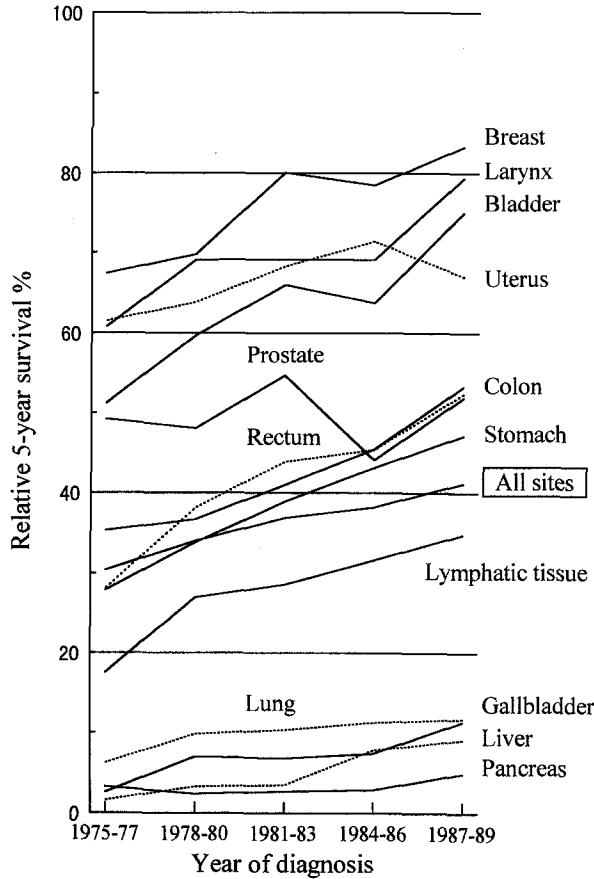


Fig. 3. Trends in 5-year relative survivals of cancer patients in Osaka

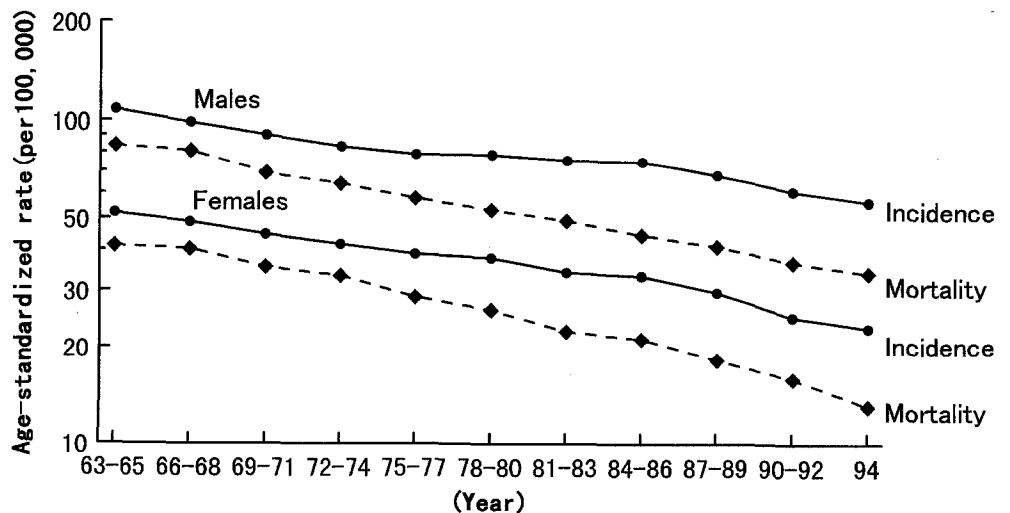
Trends in survival in cancer patients

Data on the survival of cancer patients can be provided by large hospitals and study groups interested in cancer at a specific site. However, these survival data cannot be used as an index for evaluating improvements in diagnosis and treatment of cancer patients in a defined population, because the data are selected and biased. Only survival data from population-based cancer registries can be used as an index of improvements in cancer diagnosis and treatment in the population as a whole. As shown in Fig. 3, the survival of patients with cancer at all sites has improved from 30.4% in 1975-1977 to 41.2% in 1987-1989. However, the improvement in diagnostic techniques and the wide diffusion of cancer screening programs can sometimes create an apparent improvement in survival. Therefore, the trends in survival of cancer patients should be interpreted with caution, as increasing trends can be explained at least partly by lead-time bias, length bias, and overdiagnosis bias.

In Fig. 3, three groups are discernible according to relative survival: the best survival group (cancers of breast, larynx, uterus, and urinary bladder) an intermediate survival group (cancers of stomach, colon, and rectum), and the worst survival group (cancers of liver, gallbladder, pancreas, and lung). As shown in Fig. 3, the survival of the worst group has remained at a very low level, in contrast results for the other two groups.

Although this is not shown in Fig. 3, the survival of patients with non-Hodgkin's lymphoma, lymphoid leuke-

Fig. 4. Trends in age-standardized incidence and mortality rates of stomach cancer in Osaka (standard population: world population)



mia, and childhood cancers has improved substantially in the past 15 years.

Recently, Ajiki et al.<sup>11</sup> examined trends in clinical stage distribution and survival by stage for cancers of stomach, breast, and lung. Their analysis shows that the wide distribution of early detection and improvements in treatment can explain the improvement in survival for cancers of stomach and breast and that the diagnosis of and treatment for lung cancer has created little improvement in survival as a whole. They stress that for lung cancer, efforts toward control of smoking are more important than efforts toward improvements in diagnosis and treatment. The experience of smoking control activities in such countries as the UK, the Scandinavian countries, Australia, Canada, and the US should be learned from, and much more active smoking control programs should be conducted as early as possible to stop the rapid increase in smoking-related diseases, including lung cancer.

#### Evaluation of mass screening program for neuroblastoma

A nationwide mass screening program for neuroblastoma, conducted in infants at 6 months of age, has been carried out in Japan since 1985. In 1995, about 88% of infants in Japan were screened for this tumor. In 1996, Woods et al.<sup>12</sup> reported that neuroblastoma screening by thin-layer chromatography in Quebec resulted in an increase in incidence in infants under 1 year of age without a reduction in subsequent years. This report poses a serious question about the effectiveness of the Japanese screening program.

Ajiki et al.<sup>13</sup> very recently evaluated the effects of mass screening for neuroblastoma, using data from the OCR. Because a population-based cancer registry collects data not only on the site of the cancer but also on the histology of cancer, it was relatively easy for them to analyze the time trends in incidence, mortality rates, and survival of patients with neuroblastoma. Analysis by birth cohort showed that the incidence rate at 0 years of age per 100 000 live births increased from 2.30 during 1970–1979 (before the introduction of screening) to 19.8 during 1988–1989 (screening by high-performance liquid chromatography; HPLC). The incidence rate in children aged 1 year and 2–4 years also increased with the introduction of HPLC. The mortality rate in children aged 1–4 years per 100 000 live births decreased slightly, from 3.87 in 1970–1979 to 3.30 in 1988–1989. However, most of the decrease in the mortality rate can be explained by improvements in survival due to advances in treatment.

These results strongly suggest that mass screening for neuroblastoma in Japan causes harm due to overdiagnosis and that it has little effect on reducing the incidence and mortality of neuroblastoma in children at 1–4 years of age.

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#### Uses of cancer registry data for cancer patient care: Feed back to clinicians

The OCR started a cancer information service program in 1975, in which prognostic information concerning each re-

ported patient and hospital cancer statistics have been provided free of charge at the request of participating hospitals or hospital doctors. The provision of information on the vital status of cancer patients is welcome to clinicians because it is difficult for them to follow cancer patients systematically.

At the request of participating physicians, the OCR can also provide special tables and lists which are not covered by annual reports. One recent example is the provision of data on trends in the incidence rate of testis cancer, requested by physicians interested in the health effect of dioxin on humans.

Cancer registry data are useful for the quality control of cancer screening tests. Identification of cancer cases newly diagnosed after screening (interval cases or false negative cases) was very difficult for physicians participating in cancer screening programs until a record linkage method was developed to link the files of individuals screened and the cancer registry files.<sup>14</sup> Since the development of such methods, the diagnostic validity of various cancer screening tests has been easily assessed.<sup>15–17</sup>

Cancer registry data are also useful for clinical studies, in following individuals and in observing whether they are diagnosed with cancer or not. Murakami et al.<sup>18</sup> conducted a retrospective cohort study of patients who had undergone colonoscopic examinations, using the OCR data, and showed an increased risk of colon cancer in patients with colon polyps and the possible prophylactic effect of polypectomy against subsequent colon cancer. Imai et al.<sup>19</sup> reported that the incidence of hepatocellular carcinoma was lower in chronic hepatitis C patients with a sustained response to interferon therapy than in historical controls and nonresponders, by following-up patients via a record linkage to the OCR.

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#### Uses of cancer registry data for epidemiological studies: Building and testing hypotheses of cancer etiology

Analysis of cancer registry data by time and place can provide important clues for cancer etiology. The trends in cancer incidence during the past 30 years in Japan, as shown in Fig. 2, indicate that cancer patterns by site have changed dramatically in the Japanese population, which suggests that environmental factors such as smoking and diet are very important in cancer etiology.

Geographical studies correlating cancer incidence and environmental factors, as well as migrant studies, may also result in the building of hypotheses of cancer etiology.

Cancer registry data can also be used for cohort studies in testing hypotheses of cancer etiology. Via record linkage to a population-based cancer registry file, members of the cohort can be followed easily and relatively accurately. The association between hepatitis B virus and liver cancer,<sup>20</sup> and the association between atrophic gastritis and stomach cancer<sup>21</sup> were confirmed by these methods. A negative associa-

tion between duodenal ulcer and stomach cancer was also shown by a cohort study using OCR data.<sup>22</sup>

Population-based cancer registry data can be a good source for examining common etiologic factors and for assessing the long-term consequences of chemotherapy and radiotherapy in terms of second primary cancers. Many such studies have been conducted using the OCR data.<sup>23-28</sup>

Those who are interested in cancer epidemiology and in the uses of cancer registry data can obtain more detailed information from several excellent monographs.<sup>1,29-31</sup>

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### **Hospital-based cancer registries and nationwide site-specific cancer registries**

A hospital-based cancer registry is concerned with all newly diagnosed or all hospitalized cases of cancer in a hospital. A hospital-based registry can provide survival data for evaluating the treatment conducted at that hospital. In Japan, the Research Group, consisting of national and regional cancer center hospitals, has calculated and compared 5-year survivals of cancer patients treated in each hospital as one of their collaborative studies. Okamoto et al.<sup>32</sup> reported the 5-year relative survivals of patients with cancers at major sites (i.e., stomach, colon, rectum, liver, lung and breast) in cancer hospitals stratified by stage, using standardized methods for the first time in Japan in 1996.

Studies of second primary cancers using a hospital-based registry can provide much more information than the use of a population-based cancer registry, as a hospital-based cancer registry can collect data on the life-styles of patients and details of chemotherapy and radiotherapy for the first primary cancers. Hiyama et al.<sup>33</sup> showed that the risk of developing a second primary cancer was high in laryngeal cancer patients, and that the risks were significantly increased for smoking-related cancers, with the risks higher in heavy smokers than in light smokers. Data from the hospital-based cancer registry of the Osaka Medical Center for Cancer and Cardiovascular Disease (OMCC) showed that patients diagnosed with cancer of the mouth or metho-hypo pharynx had a significantly elevated risk for developing second primary cancers of the mouth and pharynx, esophagus, larynx, and lung, with the risk of the second primary cancers being particularly high in those who had a history of current smoking at the initial diagnosis.<sup>34</sup> Ajiki et al.<sup>35</sup> suggested that smoking cessation reduced the risk of second primaries among laryngeal cancer patients, using data from the hospital cancer registry of the OMCC.

In Japan there are 18 nationwide site-specific cancer registries which deal with cancers of head & neck, esophagus, stomach, large intestine, liver, bile duct, pancreas, lung, bone & soft tissue, skin breast, uterine cervix, uterus body, ovary, bladder, brain, thyroid, and childhood tumors, respectively. Each of these registries is administered by a study group interested in the progress of diagnosis and treatment for each cancer site. These registries have collected detailed information on clinical and pathological stages (e.g., TNM classification), and some have informa-

tion on risk factors and have assessed survival of cancer by stage.<sup>36</sup> However, it should be noted that because cancer cases collected by such study groups are selected, and because their follow-up methods are not systematic, their findings on survival cannot be used as an index for evaluating improvements in diagnosis and treatment for that cancer in a defined population. Rather, the survival data from such study groups have contributed to changes in the definition of stage classification so that the new stage reflects the prognosis of cancer patients better than the old one.

Site-specific registry data over a long period are also helpful for showing changes in risk factors, information on which cannot be collected by a population-based cancer registry. For example, the Liver Cancer Study Group of Japan showed that the proportion of reported patients with primary liver cancer who were positive for hepatitis B surface antigen decreased from 40% in 1970 to 22.5% in 1987, and to 17% in 1991, and that the majority of the remaining patients are associated with hepatitis C virus.<sup>37</sup> These findings from a great number of case series have confirmed clinical impressions and have contributed very much to the planning of preventive measures for liver cancer in Japan.

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### **Conclusions and perspectives**

In this review, we have presented some examples of utilizing cancer registry data to show that the cancer registry is, as Muir et al.<sup>38</sup> described, an essential part of any rational program of cancer control, benefiting both the individual and the society in which he/she lives. It cannot be emphasized too strongly that the cancer registry does not exist for its own sake and that its most important function is its use for planning and evaluating cancer control activities, including clinical practice. The more often clinicians utilize cancer registry data and the more positively they participate in cancer registration activities, the higher the quality and the more useful the cancer registry data will become.

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