Canadian survey of thyroid cancer

W. John Simpson,* MD, FRCPC
Steven E. McKinney,† M Math

We report the results of a multicentre retrospective chart review of 2214 patients with thyroid cancer registered at 13 radiotherapy centres between 1958 and 1978. The data analysed included sex, age at the time of diagnosis, pathological diagnosis, extent of disease before treatment, types of treatment and their complications, and the rates of recurrence and survival up to 24 years after diagnosis. Although papillary cancers were most common, anaplastic and miscellaneous tumours were more frequent than expected, which reflects the type of patients referred by endocrinologists and surgeons to radiotherapy centres. There were marked differences in patterns of referral to the centres. Some patients with papillary and follicular thyroid cancers died of these cancers up to 20 years after diagnosis. The clinical manifestations, treatment and outcome of the rarer types of thyroid malignant tumours were of particular interest. The influence of age at the time of diagnosis on survival rates for patients with papillary or follicular thyroid cancer was highly significant, indicating much more aggressive behaviour of these cancers in older patients, particularly those beyond the age of 60 years. A more detailed analysis of tumour subtypes should provide new information on their natural history and lead to better management.

Analyse rétrospective des dossiers de 2214 porteurs de cancers de la thyroïde traités dans 13 instituts de radiothérapie de 1958 à 1978. On a considéré le sexe, l'âge au moment du diagnostic, le type histologique, l'étendue du processus avant le traitement, le genre de celui-ci et ses complications, et les taux de récidive et de survie sur un maximum de 24 ans après le diagnostic. Les cancers papillaires sont les plus fréquents, mais on trouve un nombre inattendu de tumeurs anaplasiques et diverses, ce qui reflète le genre de malades adressés en radiothérapie par les endocrinologues et les chirurgiens. On observe sous ce rapport d'importantes différences d'un institut à l'autre. Quelques porteurs de cancers papillaires et folliculaires en meurent au bout d'une évolution allant jusqu'à 20 ans après le diagnostic. On s'est penché particulièrement sur les symptômes, le traitement et le pronostic des formes rares de tumeurs malignes de la thyroïde. Quant aux cancers papillaires et folliculaires, leur évolutivité est significativement reliée à l'âge au moment du diagnostic: la durée de la survie est particulièrement courte si celui-ci dépasse 60 ans. Une analyse plus poussée des divers sous-types de ces tumeurs permettrait d'en mieux connaître l'évolution spontanée et d'en améliorer le traitement.

In 1981, radiation oncology members of the Canadian Association of Radiologists decided to review the treatment and outcome of thyroid cancer in Canadian radiotherapy centres. Because of the long natural history of most thyroid cancers a long-term survey of patients registered between 1958 and 1978 was undertaken. Each centre was requested to abstract the charts of 200 patients; if more were registered during this period the number of charts abstracted for each of the study years was to be a fixed proportion of the total number of patients registered during each of the study years. In this way a reasonably uniform selection of numbers and types of thyroid cancer was obtained, which permitted comparisons between eras and assessment of long-term recurrence and survival rates.

Pathological reviews were not undertaken for this survey; we relied on the original pathological reports or the reviews conducted when the patients were referred to the radiotherapy centres. This report examines characteristics of the patients referred to these centres, long-term survival rates, causes of death and factors that influence survival.

Patients and methods

Patient population

Of the 2600 worksheets sent to the 13 radiotherapy centres 2411 completed forms were returned. The information requested included the patient's sex and age at the time of diagnosis, the date of registration at the centre, pathological details, the extent of the disease before treatment was begun and after surgical intervention, the treatment methods used initially and the response to the initial treatment. Follow-up information included the interval to tumour recurrence and the site (if any), subsequent treatment, complications of therapy, date and status at the last follow-up assessment of the case, cause of death and autopsy information.

We excluded 197 of the 2411 patients: 133 were registered before 1958 or after 1978, 44 were registered at more than one centre, and for 20 the forms lacked sufficient data for analysis. Of the remaining 2214 cases, on which this report is based, 14 had no histologic or cytologic diagnosis and 25 were not known to be of thyroid origin until autopsy; these 39 cases were excluded from most of the analyses. Since complete data were not given for all the patients, the patient numbers often totalled less than 2214 in the various analyses.

From *the Department of Radiation Oncology, Princess Margaret Hospital and †the Department of Biostatistics, Ontario Cancer Institute, Toronto

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Reprint requests to: Dr. W. John Simpson, Ste. 251, Princess Margaret Hospital, 500 Sherbourne St., Toronto, Ont. M4X 1K9

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There were 608 male patients, aged from 8 to 95 years (median 56 years) and 1599 female patients, aged from 6 to 97 years (median 51 years) (Fig. 1). Age or sex was not reported for the other seven patients.

Statistical methods

The data were stored on Princess Margaret Hospital's PDP-11/70 computer. All the analyses were performed with in-house programs of the hospital's Department of Biostatistics and with the BMDP package of statistical programs.[1]

For the analysis of tabulated data the likelihood ratio[2] and Pearson's chi-square statistics[3] were used. For large samples, survival and cause-specific survival curves were estimated by the actuarial method;[4] for small samples the Kaplan and Meier method[5] was used. Survival curve comparisons were performed with the log–rank statistic and the Cox proportional hazard likelihood ratio statistic.[6]

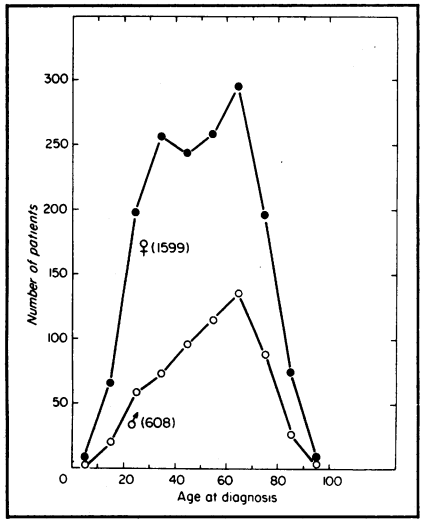

Fig. 1—Distribution of 2207 Canadian patients with thyroid cancer by sex and age at the time of diagnosis.

Results

Patient characteristics

There were marked differences among the patients referred to the various radiotherapy centres. The median age of all the female patients in the survey was 51 years, but the median was only 36 years at one centre and as high as 64 years at another. The cases referred to the centres with younger patients also had other factors indicating a better prognosis: smaller primary tumours, less frequent extrathyroidal tumour invasion and a higher proportion of papillary and follicular cancers, with fewer anaplastic cancers, compared with the centres whose patients were older when the diagnosis of thyroid cancer was made.

Tumour characteristics

About half the patients in the survey suffered from papillary (including mixed papillary–follicular) cancers, and one quarter suffered from follicular cancers (Table I). Over the 21 years surveyed there was a gradual increase in the proportion of patients with papillary cancers referred to the radiotherapy centres and a decrease in the proportion with anaplastic cancers, whereas the proportions with follicular, medullary and miscellaneous cancers were constant.

The size of the primary tumour, the frequency of extrathyroidal invasion of the primary tumour, and the frequency of neck node involvement and of distant metastases at the time of presentation are shown in Table II. Only a few of the primary tumours were less than 1 cm in diameter at the time of diagnosis, and about one fifth of the papillary cancers, one third of the

Table II—Extent of cancer at time of diagnosis

Variable	Pathological type (and no. of patients); % of patients			
	Papillary (1089)	Follicular (514)	Medullary (91)	Anaplastic (387)
Diameter of primary tumour (cm)				
< 1	9	4	2	0.5
1–4	55	45	53	14
> 4	18	36	37	68
Not stated	18	15	8	17
Extrathyroidal invasion				
No	60	57	41	11
Yes	26	25	37	60
Not stated	14	18	22	29
Neck node involvement				
No	55	67	35	32
Yes	20	9	37	26
Not stated	25	24	28	42
Distant metastases				
No	84	74	76	54
Yes	5	11	15	25
Not stated	11	15	9	21

Table I—Proportions of pathological types of thyroid cancer by year of registration at 13 Canadian radiotherapy centres*

Year of registration	Pathological type; % of patients					No. of patients
	Papillary	Follicular	Medullary	Anaplastic	Other	
1958–1962	41	26	3	23	7	286
1963–1967	44	23	4	22	7	437
1968–1972	47	24	4	18	7	498
1973–1978	54	22	5	14	5	811

***This report is based on data for 2214 patients; however, since the data were incomplete for some patients, the patient numbers often total less than 2214 in the various analyses.**

follicular and medullary cancers, and two thirds of the anaplastic cancers were larger than 4 cm. In addition, extrathyroidal invasion was identified in a very high proportion of the patients, from one quarter of those with papillary cancers to 60% of those with anaplastic cancers. Neck node involvement was frequent, as were distant metastases.

Initial treatment

Surgery was the mainstay of treatment for all the patients except those with lymphomas. Surgical procedures, ranging from subtotal lobectomy to total thyroidectomy, with or without node dissection of variable extent, were carried out for 94% of the papillary, 90% of the follicular and 84% of the medullary cancers but for only 53% of the anaplastic cancers. Thyroid hormone was used in all but 16% of the patients with papillary cancer and in all but 18% of those with follicular cancer.

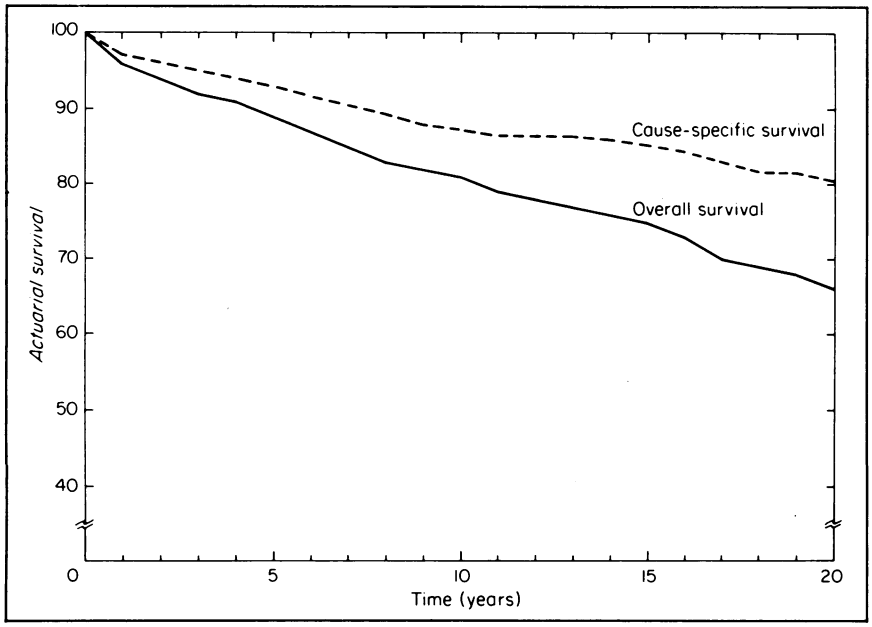

Fig. 2—Papillary cancers: cause-specific and overall actuarial survival, the specific cause of death being thyroid cancer (1062 patients).

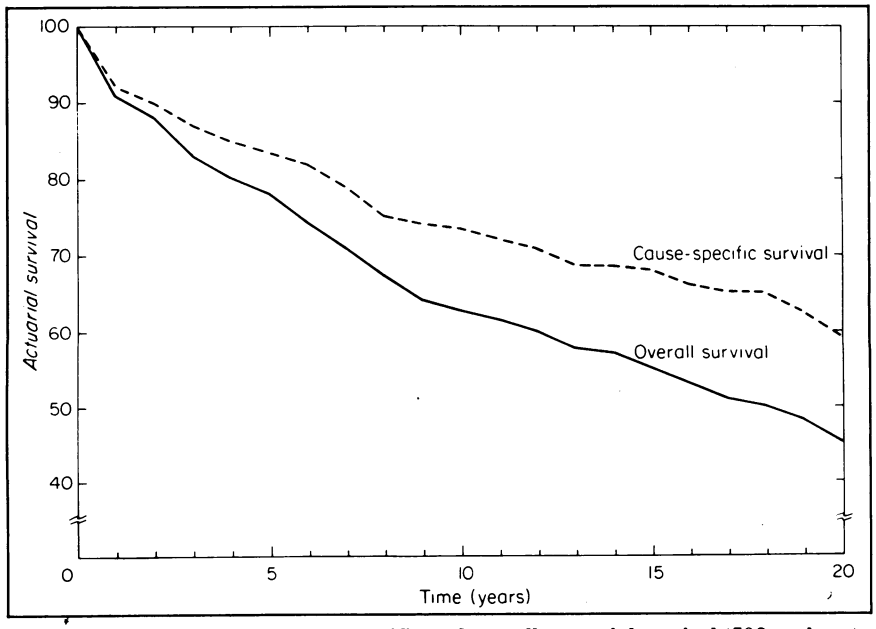

Fig. 3—Follicular cancers: cause-specific and overall actuarial survival (502 patients).

Radioactive iodine was used therapeutically in 12% of the patients with papillary and 17% of those with follicular tumours, and external radiation was used therapeutically in 14% and 10% respectively; 6% of the patients with papillary cancer and 8% of those with follicular cancer were treated with both radioiodine and external radiation. Radioiodine was also used in only 7% of the patients with medullary cancer, but external radiation was used postoperatively in 31% of these patients.

Among the patients with anaplastic cancer only 11% were treated by surgery with or without thyroid hormone; 40% were treated by surgery and postoperative external irradiation; another 40%, who had unresectable cancer, were treated with external irradiation alone; and 8% received chemotherapy, usually combined with radiotherapy.

The treatment of the miscellaneous tumours was very variable and will be described separately.

Follow-up

Most of the radiotherapy centres provided good follow-up data, with 94% of the 858 patients who were alive when their case was last assessed having been followed to January 1980 or later. However, five centres had a much lower follow-up rate, only 53% of their 427 living patients having been seen in January 1980 or later. Consequently, only 80% of the living patients, or 89% of the total group of 2214 patients, were followed adequately.

Local control and survival

Papillary and follicular cancers: Initial treatment provided local control in 77% of the patients with papillary and 70% of those with follicular cancers when local control is defined as complete eradication of local and nodal disease, with no recurrence of disease in the thyroid bed or the regional lymph nodes (irrespective of the appearance of distant metastases) at any time during the entire follow-up period. The overall and cause-specific actuarial survival curves of the patients with papillary and follicular thyroid cancer are shown in Figs. 2 and 3. Although 82% of the papillary can-

cer patients survived 10 years, more than half the deaths were due to thyroid cancer, and thyroid cancer continued to be a cause of death as long as 20 years after diagnosis. The survival rates for the patients with follicular thyroid cancer demonstrate the same phenomena, but with lower rates of survival at 5, 10, 15 and 20 years.

Medullary cancers: Few medullary tumours were represented in this survey, only 91 patients (4% of the total) having this form of thyroid cancer. The overall survival of 89 of the patients is shown in Fig. 4: 68% survived 5 years, 56% 10 years and 31% 20 years. The cause-specific survival curve indicates that the thyroid cancer caused most of the deaths in this group during the first 15 years after diagnosis but was seldom responsible thereafter, which suggests that 60% of patients are cured of medullary thyroid cancer.

Anaplastic cancers: There were 387 patients with anaplastic thyroid cancer, of whom 377 received some form of treatment. Surgical resection was carried out when possible; external radiation was used alone when the tumour masses were found to be unresectable. Local control was achieved in 23%. The survival rates of these patients were low, but not as low as is generally believed: 15% survived 5 years and 13% 10 years (Fig. 5). Of the 202 patients who had no distant metastases at the time of diagnosis 26% survived 5 years and 21% 20 years if other causes of death are excluded. Eighty-nine percent of the 303 deaths were due to thyroid cancer, with another 2% due to treatment complications.

Miscellaneous tumours (Table III)

Of the 133 miscellaneous tumours 46 were not classified into recognized pathological groups, having been reported as "adenocarcinoma", "trabecular carcinoma", "carcinoma simplex" and so on. They were probably a mixture of papillary, follicular, medullary and anaplastic cancers and were not analysed further.

The largest subgroup of patients with miscellaneous tumours consisted of 63 patients with malignant lymphoma, chiefly histiocytic, arising in the thyroid gland. Eleven (17%) were male. Only 4 (6%) of the patients were younger than 40 years, whereas 45 (71%) were over 60 years of age and 8 (13%) over 80 years at the time of diagnosis. Many of the tumours were very large (over 10 cm in diameter), and only 5 patients had tumours less than 4 cm in diameter. Involvement of neck nodes was noted in 22 of 49 patients. The presence of distant metastases (nodal or organ) was recorded in only four patients, all of whom had primary tumours larger than 4 cm, although only one patient had neck node involvement as well.

Two patients were untreated. Seven were treated with surgery alone, but local control was achieved in only three of them. In contrast, for almost all the patients (20 of 22) treated by surgery and postoperative irradiation local control was achieved. Patients with unresected (and usually unresectable) tumours generally were treated with irradiation (local control was achieved in 10 of 21 patients), although 4 (3 with local control) received chemotherapy as well. The survival rates were remarkably good, considering that most of the patients were over

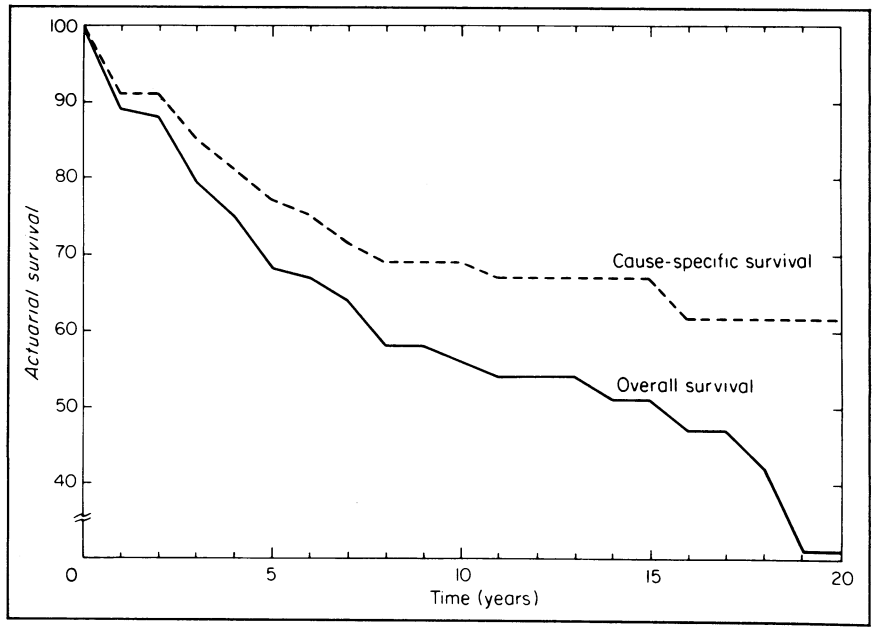

Fig. 4—Medullary cancers: cause-specific and overall actuarial survival (89 patients).

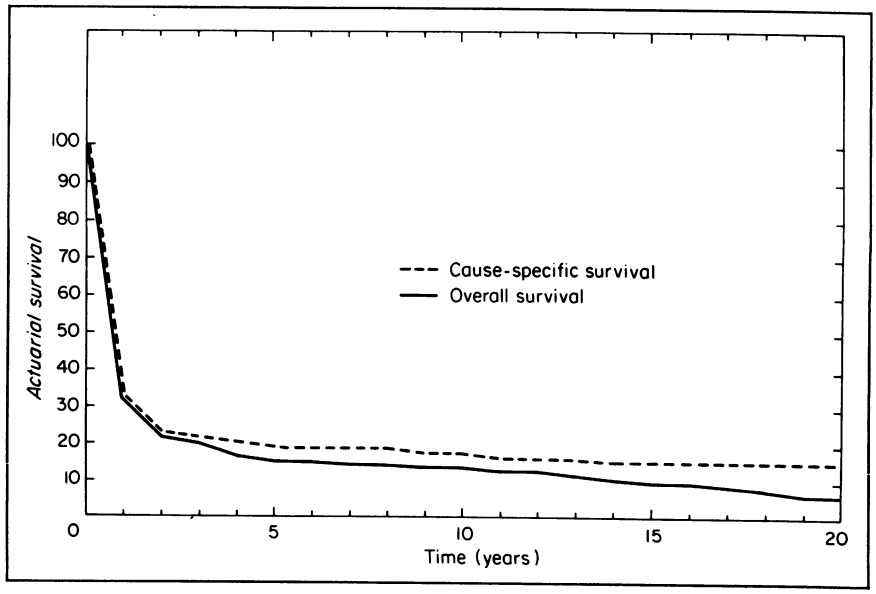

Fig. 5—Anaplastic cancers: cause-specific and overall actuarial survival (370 patients).

60 at the time of diagnosis: the overall survival rates at 5, 10 and 20 years were 50%, 44% and 38%, and the cause-specific rates were 57%, 54% and 46%. These figures emphasize the importance of adequate initial treatment, for most of these patients died of their lymphoma, not of other causes, in spite of their advanced age at the time of diagnosis.

There were 17 patients with squamous cancers of thyroid origin; the 5 men and 12 women ranged in age from 50 to 85 years (median 65 years). The diameter of the primary tumour was less than 4 cm in only 1 patient; it was 4 cm in 3 patients and over 4 cm in 10. Neck nodes were involved in 7 of 13 patients, and distant metastases were present in 2 of 14. Five patients were treated with surgery alone: one was well, free of disease, 70 months later, but the other four died of the cancer ½, 2, 2 and 6 months later. Of the five patients treated by surgery and postoperative irradiation four died of their cancer 6½ to 23 months later, and there was no follow-up information on the fifth patient. The seven patients with unresectable tumours were treated by irradiation alone: six died of the cancer 2 weeks to 5 months after diagnosis, and the seventh died of a heart attack, apparently free of tumour, 17 months after diagnosis.

Table III—Miscellaneous tumours

Tumour	No. of patients
Malignant lymphoma	63
Thyroid cancer not classified into recognized pathological groups	46
Squamous cancer	17
Fibrosarcoma	3
Angiosarcoma	1
Rhabdomyosarcoma	1
Malignant teratoma	1
Clear-cell adenocarcinoma	1

The three patients with fibrosarcomas arising in the thyroid gland were elderly (73, 76 and 80 years); two were female. They had large tumours (6, 7 and 10 cm in diameter); one had fixed neck nodes, and the others had lung metastases. In spite of surgical resection (in two patients) and external irradiation (in two), death occurred promptly: 1, 3 and 3½ months after diagnosis.

Angiosarcoma of the thyroid was diagnosed in a 71-year-old woman. Her tumour, 3 cm in diameter, was totally excised but recurred locally a month later when nodal and distant metastases were first noted; she died 2 weeks later.

A 41-year-old woman who presented with a thyroid tumour 5 cm in diameter but without nodal or distant metastases underwent a total thyroidectomy and postoperative radiotherapy for an embryonal rhabdomyosarcoma. Distant metastases appeared 4 months later, and she died 10 months after diagnosis, with local, nodal and metastatic disease.

A malignant teratoma was diagnosed in a 20-year-old man with an unresectable thyroid mass and pulmonary metastases. He was given radiotherapy and chemotherapy (vincristine, cyclophosphamide and bleomycin) without benefit and died with widespread tumour 3 months later.

Finally, a 69-year-old woman underwent total thyroidectomy and laryngectomy for a fixed mass 5 cm in diameter that proved to be a clear-cell adenocarcinoma arising in the thyroid gland, without nodal or distant metastases. Because of microscopic residual disease, postoperative radiotherapy was administered. She remains well, free of disease, 11 years later.

Survival patterns over the 21 registration years

To determine whether changes occurred in the survival of patients over the years included in the survey the patients were divided into four groups according to their date of registration: 1958–1962, 1963–1967, 1968–1972 and 1973–1978. The initial analysis of all patients registered during each period suggested that there were some differences in survival, particularly in the long term — that is, 15 to 20 years after initial treatment. However, these differences were no longer present when the pathological type of cancer and the patient's age at the time of diagnosis (0 to 44, 45 to 64 and 65 to 98 years) were included in the analyses ($p = 0.16$). Moreover, there was no trend toward a progressively better or worse survival for each successive period: the best survival was observed in patients registered during the most recent period, but the next best curve was for the patients registered in 1963–1967 (Fig. 6). Our data do

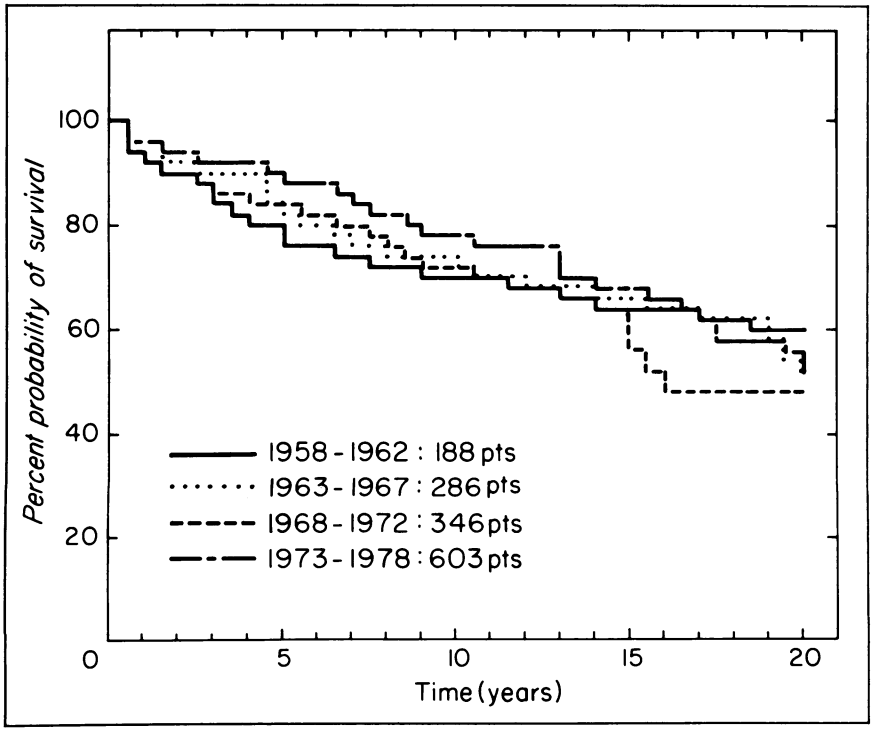

Fig. 6—Survival of patients with papillary or follicular thyroid cancer by date of registration.

not exclude the possibility of better survival for recently diagnosed cancer, for a small improvement (e.g., 10% to 15%) at 15 to 20 years would not be detected in the small number of patients in each group.

Complications

Treatment complications were not infrequent, but it must be emphasized that complications occurred most often in the patients with the most aggressive tumours, especially anaplastic cancers, or the differentiated tumours that extensively infiltrated tissues and structures adjacent to the thyroid gland. Significant complications were encountered in 15% of the 1835 patients who underwent surgical procedures, 11% of the 359 patients treated with radioiodine, 14% of the 790 patients treated with external radiation and 39% of the 61 patients who received chemotherapy. There were only 21 fatal treatment complications among the 2214 patients: 5 attributed to surgery, 2 to radioiodine treatment, 6 to radiotherapy, 4 to chemotherapy, and 1 to each of the combinations of surgery and radiotherapy, radioiodine treatment and radiotherapy, radiotherapy and chemotherapy, and surgery, radiotherapy and chemotherapy.

Cause of death

The myth that patients with papillary or follicular thyroid carcinomas rarely die as a result of these cancers should be dispelled by the findings of this survey. Although the number of deaths among these patients was not large, more than half were the direct consequence of thyroid cancer (Table IV). The frequency of cancer deaths was highest during the first 5 years after diagnosis, but thyroid cancer continued to be a cause of death up to 20 years after diagnosis, which indicates that these are chronic diseases that may prove to be fatal many years after initial treatment. Fortunately, treatment-related deaths were rare.

Similarly, Table IV shows that about half the deaths among the medullary cancer patients were due to their thyroid cancer; even after 20 years such patients may die of medullary thyroid cancer. In contrast, almost all patients suffering from anaplastic cancer die of this disease, but those who survive 2 or 3 years free of recurrence appear to be cured. Most of the patients in this survey with miscellaneous tumours other than lymphomas died of their malignant disease within a few weeks or months of diagnosis.

Prognostic factors

An analysis of the various factors thought to be important in patients with thyroid cancer was carried out: age, sex, pathological type, size of the primary tumour, extrathyroidal invasion, nodal involvement and distant metastases were studied to determine their influence on survival. Age, pathological type (papillary, follicular, medullary or anaplastic) and extrathyroidal invasion were of major importance: the cause-specific survival rate was progressively worse with increasing age ($p < 0.001$), and patients with papillary cancers fared better than those with follicular tumours, whose survival rate was better than that of the patients with medullary cancers; patients with anaplastic cancer and miscellaneous tumours were worst off ($p < 0.001$). Males had a poorer survival than females ($p = 0.013$).

The influence of age on survival was analysed for each pathological type. Age remained an important factor for papillary ($p < 0.001$) and follicular ($p = 0.003$) cancers but not for medullary ($p = 0.10$) or anaplastic ($p = 0.5$) cancers. Similarly, the influence of sex remained for papillary ($p < 0.001$) and follicular ($p = 0.06$) cancers but not for medullary ($p = 0.33$) or anaplastic ($p = 0.23$) cancers.

Discussion

Because thyroid cancers are uncommon and most of them have long natural histories there have been no prospective clinical trials to determine their most efficacious treatment. Accordingly, retrospective studies have provided most of our information about prognostic factors and the effectiveness of treatment. This survey has contributed unique information to the literature by providing data about a very large number of patients with thyroid cancers of all types and stages, observed over a very long time.

This survey suffered from the defects common to all retrospective reviews, including variable treatment policies and the omission of specific information in the records of some patients. The lack of a pathological review is probably of little importance in establishing the pathological type, for the criteria for diagnosing papillary and follicular thyroid cancers have been established for many years. However, medullary cancers and lymphomas may have been reported to be anaplastic thyroid cancers, particularly in the earlier years of the survey; this probably accounts for the deaths of the few patients who were said to have died of anaplastic thyroid cancer later than 2 or 3 years after diagnosis, as none of the 116

Table IV—Cause of death

Cause of death	Pathological type of cancer; no. (and %) of patients who died				
	Papillary	Follicular	Medullary	Anaplastic	Other
Thyroid cancer	124 (55)	130 (66)	24 (55)	303 (89)	58 (78)
Treatment complication	4 (2)	4 (2)	3 (7)	6 (2)	4 (5)
Other malignant disease	25 (11)	28 (14)	8 (18)	5 (1)	0
Other cause	63 (28)	35 (18)	9 (20)	26 (8)	9 (12)
Not stated	10 (4)	1 (0.5)	0	2 (0.5)	3 (4)
Total	226	198	44	342	74

patients at the Princess Margaret Hospital with anaplastic thyroid cancer, confirmed on later review by one pathologist, died of this disease more than 3 years after diagnosis. A more serious defect was the lack of specific information, occasionally in as many as 25% to 30% of the patients, in which case no conclusions could be made. Follow-up information was obtained on almost all the patients registered at eight centres but was not nearly so good at the other five. However, we believe that our conclusions relating to prognostic features are valid because the survival curves for patients with papillary, follicular, medullary and anaplastic cancers were similar for patients from centres with poor follow-up compared with those from centres with good follow-up information.

Patterns of referral to radiotherapy centres vary greatly from one part of Canada to another, judging by the differences in age and sex distribution and in the frequency of the pathological types between the centres. It is probable that most thyroid cancer patients are referred to the centres reporting a low median age at the time of diagnosis and a high proportion of papillary and follicular cancers, for these characteristics are similar to those reported by Mazzaferri and colleagues,[7] whose study included all patients with thyroid cancer registered at the participating hospitals. In contrast, other centres had a much higher proportion of older patients, with larger tumours, of more ominous pathological type, and more frequent extrathyroidal invasion. Consequently, direct comparisons could not be made between centres with regard to treatment methods and outcomes.

The major prognostic factors were not unexpected,[8,9] particularly the pathological type. Somewhat surprising was the importance of age in papillary and follicular cancers, which became of overwhelming significance beyond the age of 60 years. In contrast, the influence of age and sex disappeared in patients with medullary and anaplastic cancers. From the data presented here it is clear that the differentiated thyroid cancers (papillary, follicular and medullary) are chronic diseases that may recur, often with a fatal outcome, many years after initial diagnosis. Thus, we must emphasize the importance of adequate treatment initially, particularly of patients with poor prognostic factors: greater age, more ominous pathological type, large primary tumour, extrathyroidal invasion, and nodal and distant metastases.

A detailed analysis of the role of the various treatment modalities (surgery, radioiodine administration, external irradiation, chemotherapy and thyroid hormone therapy) has been undertaken and will be reported in the future.

Because there was no comprehensive tumour registry for thyroid cancers, we do not know whether the apparent increase in the proportion of papillary cancers and decrease in the proportion of anaplastic cancers represent a change in the relative incidence of these pathological types (the most probable explanation), a sampling error or a change in the accuracy of the pathological diagnosis (undoubtedly of some importance).

Our analysis of the survival of the patients treated during the four periods provided no data to indicate that better survival rates are being obtained now than previously. This is not surprising in that both radioiodine and external radiation were in general use by 1958 (the latter in only some centres), and no truly effective new modality (e.g., chemotherapy) has since been introduced.

Although not documented here, the pathologist's contribution to the management of thyroid cancer is of major importance. The correct diagnosis is frequently difficult: it may be hard to differentiate benign papillary and follicular tumours from their malignant counterparts or to determine whether an anaplastic tumour is undifferentiated papillary, follicular or medullary cancer, or a lymphoma; tests for thyroglobulin, calcitonin and lymphoma cell surface markers may be required. Equally important is the establishment of whether a microscopically complete excision has been achieved, which requires more care than may be given routinely to surgical specimens.

The miscellaneous thyroid malignant tumours reported here are of interest because of their rarity: most often, information concerning their extent, treatment and outcome is available only through case reports. Regrettably, these tumours are usually locally advanced or metastatic at the time of diagnosis, so that treatment is ineffective.

This survey has provided a wealth of data, far more than can be analysed for a single report. Subsequent analyses will examine individual pathological types in detail and assess the effectiveness of treatment for recurrent disease, both locoregional and metastatic.

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References

1. Dixon WJ (ed.): *BMDP Statistical Software, 1981*, U of Cal Pr, Berkeley, 1981: 143–206, 555–594
2. Kalbfleisch JG: *Probability and Statistical Inference*, vol 2, Springer-Verlag, New York, 1979: 148–170
3. Mendenhall W, Scheaffer R: *Mathematical Statistics with Applications*, Duxbury Pr, North Scituate, Mass, 1973: 501–516
4. Cutler SJ, Ederer F: Maximum utilization of the life table method in analysing survival. *J Chronic Dis* 1958; 8: 699–712
5. Peto R, Pike MC, Armitage P et al: Design and analysis of randomized clinical trials requiring prolonged observation of each patient. Part 2: Analysis and examples. *Br J Cancer* 1977; 35: 1–39
6. Kalbfleisch JD, Prentice RL: *The Statistical Analysis of Failure Time Data*, Wiley, New York, 1980: 70–84
7. Mazzaferri EL, Young RL, Oertel JE et al: Papillary thyroid carcinoma: impact of therapy in 576 patients. *Medicine (Baltimore)* 1977; 56: 171–196
8. Byar DP, Green SB, Dor P et al: A prognostic index for thyroid carcinoma. *Eur J Cancer* 1979; 15: 1033–1041
9. Woolner LB: Thyroid carcinoma: pathologic classification with data on prognosis. *Semin Nucl Med* 1971; 1: 481–502