Metastatic tumors of the heart, while of more frequent occurrence than primary lesions, are still of sufficient rarity to warrant the recording of a series of fourteen cases. These cases were found among 327 autopsies performed on cases of known malignancy at the State Institute for the Study of Malignant Disease.

Yater, in 1931, published a very comprehensive review of the literature, in which he quotes Karrenstein as to the incidence of cardiac metastases as follows: "In 2,161 autopsies, Chambers found 7 secondary carcinomas of the heart; from 4,547 autopsies, Willigk reported 9 secondary carcinomas of the heart, 7 of which were in the pericardium; in 4,500 autopsies, Uskoff found 1 secondary carcinoma of the heart; in about 8,500 autopsies, Napp saw 3 secondary carcinomas of the heart; at the Roth Institute of the University of Berlin (Karrenstein), among 6,655 autopsies there were 15 carcinomas (8 of which were pericardial) and 4 secondary sarcomas of the pericardium." Yater also cites the statistics presented by Peters and Milne. According to these writers, "Blumensohn reported that in 1,078 cases of disseminated carcinoma, the heart was involved in 34, and of 160 cases of sarcoma, in 12; Pic and Bret found 25 metastatic carcinomas of the heart in 1,708 autopsies; Thorel found 15 in 3,000 autopsies, and Ely 7 in 2,161 autopsies." While our report shows a high percentage of secondary involvement of the heart in proportion to the number of autopsies recorded, a ready explanation is afforded by the fact that the State Institute admits for treatment only cases of neoplastic new growth, most of which are cases of malignancy. Since all our figures are based upon cases of known malignancy, we feel that they offer unusually definite information as to the incidence of metastatic invasion of the heart.

This series, offering a fairly wide variation in the type of malignancy and in the location of the primary lesion, is grouped as shown in Table I.

In the majority of these cases general dissemination of the tumor was noted, with multiple metastases to various organs. In no case was the secondary invasion confined to the heart alone. The series consisted of 8 males and 6 females, the youngest being twelve years of age, and the oldest sixty-five. The age distribution is shown in Table II.
The time of survival of these patients after the discovery of their condition shows a wide variation. The longest period in our records is thirty-two months, and the shortest four months. The most rapidly fatal case was an endothelial sarcoma arising in the pelvis of a girl of twelve, which, despite heroic radiation therapy, advanced rapidly in four months to a fatal termination, with metastatic involvement of lung, liver, adrenals, and pancreas, and many nodules of tumor growth in the skin. Two cases of generalized lymphosarcoma progressed rapidly, with death in five and seven months respectively. Breast carcinomas proved the least rapidly fatal in the short series here recorded, one patient surviving for a period of twenty-seven and the other for thirty-two months after

<table>
<thead>
<tr>
<th>Case</th>
<th>Primary Tumor</th>
<th>Metastatic Involvement</th>
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<tbody>
<tr>
<td></td>
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<td>Heart</td>
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<tr>
<td>135 Mrs. L. B.</td>
<td>Carcinoma of ovary</td>
<td>+</td>
</tr>
<tr>
<td>151 Mr. S. H.</td>
<td>Hodgkin's disease</td>
<td>+</td>
</tr>
<tr>
<td>199 Mr. A. S.</td>
<td>Epithelioma of esophagus</td>
<td>+</td>
</tr>
<tr>
<td>225 Mrs. L. B.</td>
<td>Carcinoma of breast</td>
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<td>425 Mr. E. J. B.</td>
<td>Lymphosarcoma of neck</td>
<td>+</td>
</tr>
<tr>
<td>435 Mrs. E. J. B.</td>
<td>Carcinoma of breast</td>
<td>+</td>
</tr>
<tr>
<td>539 Mr. J. C. B.</td>
<td>Epithelioma of tongue</td>
<td>+</td>
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<tr>
<td>545 Miss M. H.</td>
<td>Endothelioma of pelvis</td>
<td>+</td>
</tr>
<tr>
<td>546 Miss M. C.</td>
<td>Melanoma of wrist</td>
<td>+</td>
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<tr>
<td>570 Mr. J. C.</td>
<td>Epithelioma of larynx</td>
<td>+</td>
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<tr>
<td>588 Mr. A. J. N.</td>
<td>Lymphosarcoma of bowel</td>
<td>+</td>
</tr>
<tr>
<td>591 Mr. S. J.</td>
<td>Embryonal tumor of kidney</td>
<td>+</td>
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<tr>
<td>607 Mrs. I. H.</td>
<td>Epithelioma of labia</td>
<td>+</td>
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<tr>
<td>623 Mr. C. R. B.</td>
<td>Melanoma of back</td>
<td>+</td>
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discovery of the initial tumor. Four cases of epithelioma are re-
corded: an epithelioma of the labium maj orum caused death in
ten months, an epithelioma of the esophagus in five months, an
epithelioma of the tongue in eleven months, and an epithelioma of
the larynx in one year. Our one patient with Hodgkin’s disease

<table>
<thead>
<tr>
<th>Decade</th>
<th>Male</th>
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<td>60-70</td>
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survived for one and one-half years while one with an ovarian car-
cinoma lived for nineteen months. The melanomas, always recog-
nized as rapidly fatal, proved no exception to the general rule, the
two cases here reported lasting but five and nine months. An
embryonal tumor of the kidney, on the other hand, showed a sur-
vival period of almost a year, despite the usually rapid fatal termi-
nation in these cases.

The size, shape, and number of metastatic tumor nodules found
in the different hearts in this series varied considerably. In one
case the metastases consisted of minute white implants on the
heart muscle; in another a considerable portion of the cardiac
muscle was replaced with tumor tissue. Between these extremes
varying degrees of involvement of heart muscle were observed.
The majority of the cases showed more involvement of the left than
of the right side of the heart. In no case was involvement of any
of the heart valves observed. A study of the history in each case
showed that, regardless of the degree of involvement, no cardiac
symptoms were demonstrable during life.

The mechanism of the implantation of tumor tissue in cardiac
muscle must vary considerably in individual cases. Where meta-
static growths already exist in the lungs, it is conceivable that tu-
mor cells may invade the vessels of the lung and be swept by the
blood stream through the pulmonary veins into the left heart and
thence into the coronary arteries and their smaller branches. In
this manner implants throughout the heart muscle might readily
occur. It is probably also possible that, where extensive lymph
node involvement is present, tumor cells might find their way into
the lymphatic duct and the superior vena cava through the bron-
chial and azygos veins. Where the lymph nodes in close proximity
to the heart itself are involved in metastatic tumor growth, as in the case of the tracheobronchial lymph nodes, which drain the pericardium and myocardium, as well as the pleura, retrograde conduction along lymphatic channels would allow a direct growth of tumor cells backward to the heart muscle.

While the majority of the cases reported showed definite evidence of metastases when admitted to the Institute for treatment, careful examination of x-ray plates of the chest, made at regular intervals during treatment, fail to reveal any signs which would justify a diagnosis of heart involvement. In no case was the me-

![Figure 1](image)

**Fig. 1. Case 135, Mrs. L. B.: Teratoma of Ovary, Metastatic in Heart**

tantasis to cardiac muscle suspected during the life of the patient, being revealed only at autopsy.

A brief history of each case with the principal clinical and autopsy findings is appended.

**Case Reports**

**Case 135:** Mrs. L. B. was a married woman of thirty-eight, with two children. There was no history of cancer in the family. In August, 1920, she suffered a severe fall, and shortly afterward began to suffer from pains in her back. On Sept. 7, 1920, a large tumor was removed from the left side of the pelvis, and was diagnosed as a malignant leiomyoma. On admission to the Institute, on Oct. 13, 1920, there was no demonstrable pathology in the pelvis. Postoperative x-ray treatment was given. On Dec. 11, 1920, a distinct nodule was palpable on the right upper pole of the uterus. Treatment was given, but the nodule increased in size. On Aug. 2, 1921, a definite recurrence was found in the posterior
wall of the vagina and cul-de-sac, with a small node in the left axilla. X-ray plates, taken Oct. 22, 1921, showed distinct infiltration of lungs around the hilus with mottling of the left lung. Examination on Nov. 9, 1921, showed a large, hard, infiltrating mass involving the whole pelvis between the vagina and rectum. Under treatment the pelvic tumor diminished in size, but the patient died on March 26, 1922.

At autopsy large tumor masses were found in the region of the right and left ovary. These were found to be a teratoma of the ovary which had metastasized to the lung, kidneys, and heart. The growth which had invaded the heart was made up of cells with large, hyperchromatic nuclei with many giant cells present. The spindle cells, which predominated, were large, with granular cytoplasm and vesicular nuclei. This tumor had replaced heart muscle and was found infiltrating between the strands (Fig. 1).

![Fig. 1. Case 151, Mr. S. H.: Hodgkin's Disease, Metastatic in Heart](image)

**Case 151:** Mr. S. H., aged twenty-four, single, gave no history of cancer in the family. In March, 1921, his throat became sore and there was swelling in both sides of the neck. He attempted to relieve the condition with home remedies. Examination on admission, April 25, 1921, showed palpable lymph nodes on both sides of the neck, in the left axilla, and in the inguinal regions. On April 26, 1921, a node on the left side of the neck was removed, and a diagnosis of Hodgkin's disease was made. Treatment with the radium pack was instituted. Examination on June 29, 1921, showed that the nodes had disappeared under treatment. X-ray plates of June 12 showed a broader mediastinal shadow than normal. Radium treatment was continued on Aug. 15 and Dec. 11, 1921, and May 15, 1922. X-ray therapy was given on June 13, 1922, and Aug. 14, 1922. X-ray plates taken at this time showed distinct evidence of mediastinal involvement and fluid in the right chest. On Oct. 12, 1922, chest plates showed consolidation of the left chest. The patient became progressively worse, and died on Oct. 25, 1922.
At autopsy there was found a generalized lymph node involvement of Hodgkin's disease, metastatic in lung, spleen, pleura, and heart. Miliary and somewhat larger discrete and confluent nodules were found on both surfaces of the pericardial sac, on the epicardium, and on the serosa covering the great vessels. Histologically the masses were made up of plasma cells and eosinophils with many endothelial giant cells. A small amount of fibrosis was present (Fig. 2).

Case 199: Mr. A. S., aged sixty-five, married, gave no history of cancer in the family. About the 1st of September, 1924, his throat became sore, followed by difficulty in swallowing. On admission, on Oct. 25, 1924, examination showed a cauliflower-like bleeding mass in the esophagus, 36 cm. from the upper alveolar arch. Tissue was removed for examination, and the report was epithelioma with pearls. Radium treatment was given. The patient was not able to take solids, and finally refused all nourishment. On Jan. 3, 1925, a gastrostomy was performed. Improvement followed at first, but death occurred on Jan. 24, 1925.

At autopsy there was found an epithelioma of the esophagus with metastases to the cardiac end of the stomach, adjacent lymph nodes, heart, and lungs. Examination of the heart showed a whitish nodule 1 cm. in diameter, 0.5 cm. thick, extending through the heart muscle on the left side, 2 cm. from the apex. This nodule, which had infiltrated and replaced cardiac muscle, was made up of flat epithelial cells growing in places in cords of granular cells, and in other places forming an alveolar structure. There was present a small amount of hornification with marked fibrosis of surrounding tissue (Fig. 3).

Case 225: Mrs. L. B., fifty-seven years old, was married and had one child. There was no history of cancer in her family. In May, 1923, she noticed a lump in her right breast. This was removed on Jan. 7, 1924, in Budapest, Hungary. On admission to the hospital on July 23, 1924, examination showed the scar of a radical breast amputation, but no evidence of recurrence. X-ray treatment was given. At this time chest plates were negative for mediastinal involvement. On
March 16, 1925, there was found a palpable node in the right supraclavicular region. On June 15, 1925, nodes were distinctly palpable in the right axilla. Several skin metastases appeared in July, 1925. X-ray treatment was continued, but there was increased metastatic involvement. The patient became worse, despite all treatment, and died on Feb. 28, 1926.

At autopsy recurrent carcinoma of the breast was found, with metastases in the skin, thyroid, lungs, liver, uterine wall, kidneys, suprarenals, bladder wall, heart, and retroperitoneal, cervical, axillary and mediastinal glands. The tumor in the heart was made up of a solid collection of granular cuboidal cells with no attempt at gland formation. It consisted of two solitary nodules on the left ventricle, measuring about 1 cm. X 1 cm. (Fig. 4).

FIG. 4. CASE 225, MRS. L. B.: CARCINOMA OF BREAST, METASTATIC IN HEART

CASE 425: Mr. E. J. L., aged twenty-eight, single, gave no history of cancer in the family. In September, 1929, he complained of dry cough and loss in weight; nodes were palpable in both axillae, the groin, and on both sides of the neck. Fluoroscopic examination on admission, Nov. 29, 1929, showed considerable fluid in the right chest with widening of the mediastinal shadow. Microscopic examination of a node removed from the axilla showed it to be lymphosarcoma. High-power x-ray treatments were given. There was some diminution of the nodes at first but gradually they became larger. Death occurred on March 30, 1930.

At autopsy there was found a lymphosarcoma widely distributed among the lymph nodes in kidneys, heart, lungs, and pancreas. In the heart was a diffuse growth into the cardiac muscle, made up mostly of lymphocytes with an occasional plasma cell and eosinophil.

CASE 435: Mrs. E. J. B., aged forty-nine, was married and had one child. There was no history of cancer in her family. In January, 1928, the patient noticed a small lump under the right breast, which gradually increased in size. In February, 1929, the breast was removed and the axilla cleaned out. The tissue removed proved to be carcinoma. The patient was admitted to the hospital for
treatment on March 27, 1929. No recurrence was observed in the operative scar or axilla, but there were definite metastases in the right supraclavicular region. Chest plates at this time showed no evidence of mediastinal involvement or lung infiltration. X-ray therapy was instituted, but the patient was very irregular in appearing for treatment. Chest plates on Dec. 6, 1929, showed thickening and calcification in both hilus regions, with a small amount of fibrosis in both sides; the heart shadow was normal. The patient died on May 22, 1930.

At autopsy there was found metastatic carcinoma of lungs, spleen, thyroid, suprarenals, pancreas, heart, kidneys, lymph nodes, and liver. The tumor in the heart was a small nodule made up of cuboidal cells replacing heart muscle, but not infiltrating to any great degree.

Case 539: Mr. J. C. B., aged fifty-five, married, gave no history of cancer in his family. In 1929 he noticed a small pimple on the tip of his tongue, but this finally disappeared. In September, 1930, the left side of the tongue became sore and swollen, the condition growing gradually worse. On admission, on Nov. 3, 1930, there was found a growth involving the left side of the tongue and floor of the mouth, extending across the midline anteriorly under the surface of the tongue. Small nodes were palpable in both sides of the neck. Biopsy on Nov. 4, 1930, showed pearl-cell epithelioma of the tongue. Treatment was given but the patient became worse, and died on Aug. 12, 1931.

Autopsy showed an epithelioma of the tongue metastatic in liver, lungs, heart, cervical nodes, and suprarenals. The tumor in the heart consisted of numerous small white nodules scattered throughout the heart wall. These proved to be an infiltrating epithelial tumor with considerable pearl formation (Fig. 5).

Case 545: Miss M. H., aged twelve, gave no history of cancer in the family. In 1930 she fell from a swing and wrenched her left leg. In November, 1930, a tumor was removed from the leg above the knee, which was reported as an endothelioma. Three x-ray treatments were given. In March, 1931, the left leg

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**Fig. 5.** Case 539, Mr. J. C. B.: Epithelioma of Tongue, Metastatic in Heart
FIG. 6. CASE 545, MRS M. H.: ENDOTHELIOMA, METASTATIC IN HEART

FIG. 7. CASE 546, MRS M. C.: MELANOMA OF WRIST, METASTATIC IN HEART
began to swell. On entrance to the Institute in the same month, examination showed a long scar on the inner side of the right thigh with definite metastases in the left groin and palpable nodes in the left side of the neck. Treatment was without avail, and the patient died on Sept. 16, 1931.

Autopsy revealed tumor masses in lung, intestinal wall, liver, suprarenals, both breasts, pancreas, and heart. The heart contained several white tumor nodules which on histological examination proved to be made up of small round cells with clear cytoplasm and small nuclei diffusely distributed through the muscular stroma (Fig. 6).

CASE 546: Miss M. C., aged fifty-six, stated that her father had died of cancer of the lip, and that her paternal grandmother had cancer of the face, which, however, did not cause her death. On June 27, 1930, the patient had a pigmented mole removed from the right wrist by fulguration, followed by x-ray treatment. On June 29, 1931, a lump was removed from the right axilla, which proved to be a melanoma. X-ray treatment was given on July 25 and Aug. 22. On Sept. 5, 1931, the family physician noticed a small nodule in right supraclavicular region. The patient was admitted to the Institute on Sept. 9, 1931. Examination showed nodes in the right supraclavicular region and right axilla with skin nodules in the right axilla. No nodes were felt in the left axilla or groin. Chest plates revealed fine mottling in both lungs and nodes in the hilus of the right side. High power radiation was given. The patient died on Sept. 21, 1931.

At autopsy there was found a melanoma metastatic in rib, suprarenals, spleen, liver, lungs, heart, kidney, and axillary, mediastinal, bronchial and retroperitoneal nodes. The heart showed tumor masses 0.5 to 1 cm. in diameter throughout the muscle. Examination of one of these nodules showed a collection of round and spindle-like cells replacing the heart muscle. No pigment was found (Fig. 7).

CASE 570: Mr. J. C., aged 52, single, gave no history of cancer in the family. In December, 1930, he noticed a lump in the left side of the neck, which became larger. In July, 1931, it was lanced by the family physician, and after this there was a constant discharge. On Nov. 6, 1931, a section taken from the right side

FIG. 8. CASE 570, MR. J. C.: METASTASIS IN HEART FROM EPITHELIOMA OF THE LARYNX
of the neck showed a pearl-cell epithelioma. On admission, Nov. 20, 1931, there was found a large ulcerating tumor involving the submaxillary and submental regions. In both sides of the neck were metastatic lymph nodes. No ulceration was visible in the oral cavity. X-ray treatments were given, but the patient expired on Dec. 3, 1931.

At autopsy there was found a pearl-cell epithelioma of the larynx, metastatic in the suprarenals, heart, and bronchial and abdominal glands. The vessels of the lung were filled with tumor cells which did not infiltrate into the lung tissue. The tumor in the heart was limited to a solitary nodule on the left side (Fig. 8). This nodule was white and measured about 2 × 3 cm. Histologically it was a pearl-forming epithelial tumor infiltrating and replacing heart muscle (Fig. 9).

**CASE 588:** Mr. A. J. N., aged twenty-one and married, reported that his grandfather had died of carcinoma of the stomach. In 1925 the patient began to have frequent bowel movements and complained of pain and aching in the lower bowel. In 1927 he was operated upon for ptosis of the transverse colon, and an appendectomy was done. A second operation was performed in 1930, for adhesions and ptosis. In April, 1931, lumps were noticed in the left axilla, and these increased in size, while small lumps appeared, also, in the right groin. The patient had difficulty in retaining urine. On his entrance, in September, 1931, examination showed palpable nodes in the right axilla, a large node in the left axilla, smaller nodes in both groins, and a mass in the lower abdomen. The liver was enlarged. A diagnosis of lymphosarcoma was made, and was confirmed by biopsy on Sept. 22, 1931. A blood count in September, 1931, showed 4,416,000 red cells and 9,500 white cells. In November there were 4,800,000 red and 11,500 white cells. Another count, in January, 1932, showed 3,584,000 red and 13,500 white cells. Treatment was of no avail, and the patient died on Feb. 2, 1932.

Autopsy showed lymphosarcoma in the intestinal wall, heart, pancreas, and thyroid, and general node involvement. The heart was studded with whitish
nodules of varying size, which histologically showed an infiltration of heart muscle with lymphoblastic cells (Fig. 10).

Case 591: Mr. S. J., aged forty-four, single, gave no history of cancer in the family. On October, 1931, a small pimple had appeared on the left side of the chin and right side of the neck below the ear. Gradually this increased in size. On admission, on Dec. 2, 1931, the patient showed a lesion on the right cheek, a fluctuating raised red lesion on the chin, and large nodes in the right side of the neck and the right submaxillary region. Chest plates showed increase in size of the nodes at the hilus of both lungs, with an irregular mass in the left chest which looked like metastatic tumor. One x-ray treatment was given. The patient died on Feb. 10, 1932.

At autopsy there was found an embryonal tumor of the kidney showing both sarcomatous and carcinomatous changes; no striated muscle was found; metastases

![Fig. 10. Case 588, Mr. A. J. N.: Lymphosarcoma, Metastatic in Heart](image-url)

were present in the liver, lung, thyroid, heart, and skin. The heart showed several tumor growths (Fig. 11). On the posterior aspect of the right ventricle was a tumor mass about 2 cm. in diameter, projecting beneath the pericardium. This involved the muscle. A similar mass of like size was observed in the posterior wall of the left ventricle. There was a smaller node in the anterior portion of the left ventricle and another in the muscle of the heart apex. A large area of tumor infiltration, about 4 × 2 × 2 cm., was found just below the left auriculo-ventricular groove anteriorly. On section a white metastatic tumor mass about 1 cm. in diameter was found in the papillary muscles of the left ventricle posteriorly. Histologically the tumor consisted of numerous large and small spindle cells; occasionally round cells and large giant cells are observed (Fig. 12).

Case 607: Mrs. I. H., aged fifty-seven, was married but had no children. Her father had cancer of the face but that was not the cause of his death. In August, 1931, the left labium became sore, with smarting and burning on urination. On Jan. 6, 1932, a section removed from this region showed pearl-cell epithelioma.
Fig. 11. Case 591, Mr. S. J.: Multiple metastases in heart from an embryonal tumor of the kidney.

Fig. 12. Case 591, Mr. S. J.: Embryonal tumor of kidney, metastatic in heart.
On admission, on Jan. 20, 1932, examination showed epithelioma of the left labium, with metastatic nodes in the left groin. Chest plates showed no mediastinal involvement or lung infiltration. X-ray treatment was given. The general condition of the patient was very poor, and she died on April 13, 1932.

An epithelioma of the labia was found at autopsy with metastases in the suprarenals, lung, heart, and liver. The tumor in the heart was limited to three small nodules infiltrating the cardiac muscle. Histologically it showed an infiltrating mass of epithelial cells. A small amount of hornification was observed.

Case 623: Mr. C. R. B., aged forty-six, was single, with no history of cancer in the family. He had had a large black wart removed from his back by the family physician in September, 1931. The tissue removed was not submitted for examination. On May 1, 1932, a bunch was removed from the left shoulder blade.

and a diagnosis of melanoma was made. The patient was then referred to the Institute for treatment. On admission, on May 10, 1932, nodes were felt in both sides of the neck, both arms, both inguinal regions, and the left axillary space. The liver was enlarged. Chest plates taken at this time were negative for mediastinal involvement or lung infiltration. Treatment was started with the radium pack. The patient became worse, however, and died on June 7, 1932. At autopsy melanoma was found widely disseminated through the lymph nodes, in the omentum, heart, pancreas, lung, suprarenals, and mesentery. Examination of the heart showed numerous nodules beneath the pericardium. These were black in color and varied in size from a pin point to 2 cm in diameter (Fig. 13). On section, similar nodules were found in the heart muscle and beneath the endocardium. Histologically the heart muscle was replaced by a heavily pigmented tumor mass made up of round and spindle cells.
Conclusions

In a study of 327 autopsies on patients with known malignancy, 14 cases of metastatic involvement of the cardiac muscle were found. This constitutes approximately 4.3 per cent of routine autopsies made in such cases at the State Institute for the Study of Malignant Disease. While this proportion seems somewhat higher than a review of the literature would indicate, it can probably be explained by the fact that this series includes only cases in which malignancy was definitely established and was definitely the cause of death.

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