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*Special Article*

# The Management of Oesophageal Carcinoma: Radiotherapy or Surgery?

## Cost Considerations

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**Abstract**—*A cost comparison has been made between two treatment modalities used with curative intent for carcinoma of the oesophagus, for 144 patients seen between December 1979 and December 1985. Forty-two patients were selected for radical oesophagectomy. In this paper these are compared with 50 patients who underwent radical radiotherapy. The median survival of both groups was identical (12 months). The remaining 52 patients underwent a variety of palliative procedures and are not considered further.*

*Components of management were identified and costed on the basis of direct resource use by the hospital. Surgically treated patients on average cost $A13,638 in 1987 dollars, whereas those treated by radiotherapy cost $A3533. The major factors accounting for this cost difference were the necessary perioperative intensive management in the surgical group, the inevitable perioperative complications and the subsequent prolonged hospitalization of a proportion of patients. The cost of the management of the complications of radiation therapy are included but were not a major factor in overall costs for the irradiated group.*

*This cost differential must influence the continuation of current strategies in which radical surgery, rather than irradiation, is the selected routine curative approach for oesophageal cancer particularly in the absence of evidence of higher survival.*

## INTRODUCTION

CANCER OF THE OESOPHAGUS is an uncommon disease, accounting for only 1.4% of all cancers [1]. It has a very gloomy prognosis with a median survival reported to be between 6 and 14 months and with only 4–9% surviving, disease free, for over 5 years [2–4]. The standard approach in the past has been radical surgical excision with mortality rates varying between 1.4% [5] and 37.5% [6] with no significant evidence that control of operative mortality is reflected in higher survival rates. Radiation therapy as a curative modality has also been used, usually in those for whom the risk of major surgery was considered too great. Median survivals for those treated by either method are identical—in the order of 6–14 months.

The purpose of this paper is to present the comparative costings for the treatment of oesophageal cancer with curative intent by surgery or by radiotherapy. The costs were those which occurred from the first diagnosis till the time of final hospitalization for terminal care.

The group of patients is the same as that which has been reported by O'Rourke *et al.* [7, 8] where there were no differences in survival for curative surgery and curative radiotherapy when compared using Kaplan–Meier survival curves and log-rank statistics and where surgical mortality was nil. The advantages or disadvantages of one modality over the other therefore lie with other considerations, which include 'quality of life', determined largely by side-effects and control of dysphagia and with the costings of treatment.

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## MATERIALS AND METHODS

Records of all patients treated for carcinoma of the oesophagus or oesophago-gastric junction at Westmead Hospital from December 1979 to December 1985 were reviewed. This review yielded 144 patients who have been evaluated and managed according to an agreed protocol. Fifty-two patients were treated palliatively, either by insertion of Atkinson's tube, a palliative course of irradiation or by symptomatic means. These 52 patients are not considered further in this study.

Ninety-two patients were treated with curative intent. Forty-two were selected for radical surgical resection and the remaining 50 were referred for radiotherapy (median dose 56 Gy) (Fig. 1). The techniques of surgery and radiotherapy used are fully described by O'Rourke *et al.* [7]. Details of the patients, tumour characteristics and management according to treatment modality are given in Table 1A, B and Fig. 1. Fourteen patients treated by resection had planned pre- or post-operative radiation therapy and in both groups 5-fluorouracil and mitomycin C chemotherapy was given to 38 patients as a radiation enhancer [9].

In Australia, hospital accounting records do not provide information on the cost of treating disease groups or of treating individual patients. It was therefore necessary to estimate costs using data obtained from each individual patient record, from direct observation in the radiotherapy department and from records of hospital expenditure. We were obliged, as a first approximation, to devise units of service and then to cost their utilization. These are given in Tables 2 and 3.

The basis for the cost estimates is the actual use by the hospital of the devised units of service in treating patients from referral with a positive diagnosis to final hospitalization for terminal care. Thus no attempt has been made to include and apportion joint and overhead costs. The costs of initial diagnostic and investigative procedures have not been included as the diagnostic evaluation was identical for all patients irrespective of eventual treatment. Final hospitalization for terminal care was also

*Table 1A. Comparison of surgically treated and radiation treated cases*

| | Surgery ($n$ = 42) | Radiotherapy ($n$ = 50) |
|---|---|---|
| *Patient characteristics* | | |
| Age (median) | 61.5 years | 64.5 years |
| Performance status* (median) | 1 | 1 |
| *Treatment characteristics* | | |
| Surgery patients receiving pre- or post-operative XRT | 14 | N/A |
| Median XRT dose (for those receiving XRT) | 50 Gy | 56 Gy |
| Patient receiving concomitant 5-fluorouracil–mitomycin C chemotherapy with radiotherapy | 4 | 34 |

*Using ECOG rating 0–4.

*Table 1B. Comparison of tumour characteristics between surgically treated and irradiated subgroups*

| Tumour characteristics | | Surgery ($n$ = 42) | Radiotherapy ($n$ = 50) | |
|---|---|---|---|---|
| (a) | Pathology: | | | |
| | Squamous cell carcinoma | 17 | 44 | $P < 0.001$* |
| | Adenocarcinoma or other | 25 | 6 | |
| (b) | Length: | | | |
| | <5 cm | 30 | 15 | $P = 0.042$* |
| | >5 cm | 6 | 25 | |
| | Not known | 6 | 10 | |
| (c) | Level (cm from incisor teeth): | | | |
| | Upper (0–19 cm) | 1 | 5 | |
| | Middle (20–29 cm) | 12 | 20 | |
| | Lower (30–40 cm) | 29 | 25 | |

*Chi-squared value.

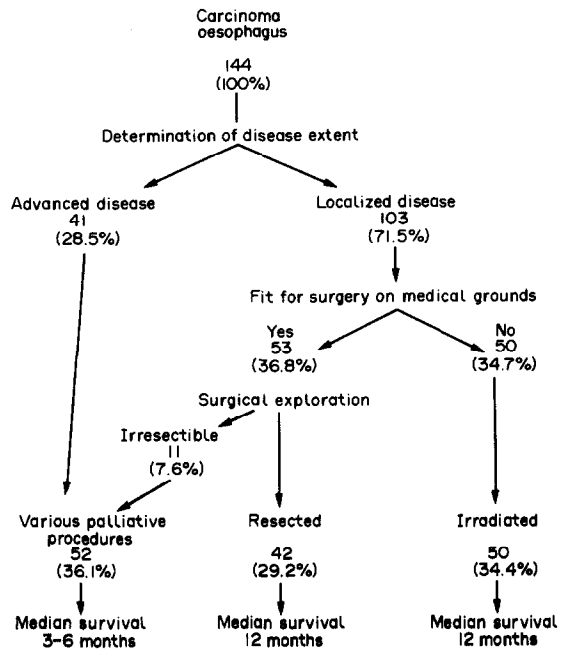


*Fig.* 1. *Summary of treatment and outcome of* 144 *patients treated at Westmead from* 1979 *to* 1985.

excluded. Terminal care was often carried out in nursing homes and it was not possible to determine in many cases its effect and costs. However, when comparisons could be made, the duration and content of terminal care were independent of initial management.

Bed day costs were calculated using actual surgical ward nursing salaries, goods and services expenditure; average meal production costs, allocated housekeeping staff and resident medical staff costs. Oesophageal cancer patients were not differentiated from other surgical cases on that particular surgical ward. Costs of antibiotic and chemotherapeutic agents were those quoted by the hospital pharmacy as being the actual cost charged to the pharmacy by the manufacturers and suppliers.

Operating theatre time was costed on the basis of April 1987's actual expenditure on salaries and goods and services for theatres and the central sterilizing unit and the cost of allocated housekeeping staff was added. Total costs were divided by hours of operating time to give an hourly cost.

*Table* 2. *Surgical treatment costs*

| Units of service | Average useage | Unit cost | Value cost ($A) |
|---|---|---|---|
| *Inpatient treatment* | | | |
| Operating theatres | 9.43 O/T h | 498.79 | 4704 |
| Intensive care units | 5.26 days | 640.21 | 3368 |
| Surgical ward | 34.83 days | 83.53 | 2909 |
| T.P.N. (goods only) | 14.6 days | 89.74 | 1310 |
| Antibiotics | | | 308 |
| Miscellaneous (see text) | | | 20 |
| *Subsequent management* | | | |
| Further admissions | 6.66 days | 83.53 | 556 |
| Miscellaneous costs (see text) | | | 463 |
| Total | | | 13,638 |

*Table* 3. *Radiation treatment costs*

| Units of service | Average useage | Unit cost | Value cost ($A) |
|---|---|---|---|
| *Curative XRT* | 64.98 fields | 14.83 | 964 |
| Simulation/planning | 1.24 sessions | 176.47 | 219 |
| Medical | 2 h consultations | 60.00 | 120 |
| Nursing | 2 h consultations | 13.00 | 26 |
| 5-Fu/mito C chemotherapy | 1.36 courses | 149.22 | 203 |
| Inpatient days | 6.2 days | 83.53 | 518 |
| *Subsequent management* | | | |
| Management of complications | 11.84 days | 83.53 | 989 |
| Dilatation | 1.24 procedures | 258.11 | 320 |
| Miscellaneous (see text) | | | 174 |
| Total | | | 3533 |

Medical staff costs were allocated on estimates of time/staff involved by procedure. There was no inclusion of the costs of building and equipping the operating theatre suite.

Radiation Oncology costs included planning and treatment. An average staff cost per planning session was estimated. Treatment was costed for two, three and four field treatments separately based on observed staff time. An allowance was made for the capital cost of the linear accelerator, simulator and planning computer. The current (1987) replacement costs of these items were depreciated using straight line method over 15 years (linear accelerator and simulator) and 10 years (planning computer) plus an allowance for annual maintenance. These were apportioned per field of treatment and per planning session using patient throughput for the most recent calendar year (1986). Housekeeping costs were estimated as for wards and operating theatres and apportioned to occasions of service.

Miscellaneous costs include cost of consultations outside the treatment team, supply of blood, palliative radiotherapy and various minor endoscopic procedures which together constitute a very small fraction of the total cost.

Costs are based on those pertaining at the time of the preparation of this report and no attempt has been made to adjust for inflation during the period covered by the study as the ratio of costs is the main purpose of the study. All staff costs include an appropriate departmental 'on cost' allowance for items such as annual and sick leave/superannuation.

## RESULTS

Cases treated by radiation therapy do not differ from those treated by surgery except with regard to:

(i) a greater proportion of cases of adenocarcinoma ($P < 0.001$) treated by surgery.
(ii) a greater proportion of more advanced tumours, i.e. >5 cm length, treated by radiation ($P < 0.05$) (Table 1B).

The pattern of treatment and the average cost per surgical patient is shown in Table 2; and for the radiotherapy patients in Table 3. The cost of treating a surgical case is approximately $A13,500 compared to $A3500 for a radiotherapy case. The cost of the initial operation, the requirement for 'routine' ICU (intensive care unit) and TPN (total parenteral nutrition) for all surgical cases and the complications which required prolonged initial admission in hospital are the major factors in the cost of surgical treatment compared to radiotherapy. Complications of radiotherapy were, in general, late and were capable of being dealt with on an outpatient or short stay admission basis.

The cost of surgery as estimated on this direct resource use basis as 'curative' treatment for oesophageal cancer at Westmead Hospital was 3.9 times greater than that of radiotherapy for the same median survival and with, in our opinion, no evidence of better palliation to justify such a cost differential.

The 'patient cost' in terms of complications for each arm are listed in Table 4. As can be seen, there is *no* operative mortality—a considerable tribute to surgical and nursing skills—but three patients died while receiving radiotherapy for causes listed in Table 5. The quality of life and degree of symptom palliation of the patients has not been directly measured. Indirect measures of quality of life include the time spent in hospital and the side-effects experienced. Tables 2 and 3 show that, on average, a total of 47 days and 18 days for surgery

*Table 4A. Complications of surgical treatment*

| | | Patient No. |
|---|---|---|
| *Acute:* | Anastamotic leak | 1 |
| | Respiratory failure | 6 |
| | Severe chest infection | 9 |
| | Subphrenic abscess | 1 |
| | Septicaemia | 4 |
| | Wound infection | 2 |
| | Perioperative death | 0 |
| *Chronic:* | Benign stricture | 3 |
| | Malignant stricture | 1 |

*Table 4B. Complications of radiotherapy treatment*

| | | Patient No. |
|---|---|---|
| *Acute:* | Haematological requiring treatment modification | 6 |
| | Gastrointestinal requiring treatment modification | 1 |
| | Serious infection | 4 |
| | Respiratory | 3 |
| | Cardiac | 1 |
| | Periradiotherapy death | 3 |
| *Chronic:* | Benign stricture | 16 |
| | Malignant stricture | 9 |

*Table 5. Causes of death in patients dying within 30 days of completion of radiotherapy or surgery*

*Surgery*
No deaths

*Radiotherapy*
Three patients
1. Invasion of trachea by tumour and subsequent pneumonia
2. Pneumonia
3. Cause unknown

and radiotherapy patients respectively were spent in hospital. Table 4 lists the complications which were seen in the two groups. Side-effects were usually acute in surgical cases but often delayed in irradiated cases who required dilatation of strictures. The acute complications listed for radiation therapy may have been enhanced by the concomitant use of chemotherapy in 68% of cases. However, O'Rourke *et al.* [8] reviewed the ability to swallow and stricture formation in the radiotherapy group and concluded that quality of life was excellent in those with benign strictures only. Chronic stricture requiring treatment was more common with radiotherapy patients but did not lead to reduced quality of life unless the stricture was due to relapse of malignancy [8]. Using these admittedly indirect measurements, we can surmise that there is probably not much difference in quality of life between the two groups. However, no formal evaluation of palliation was undertaken in these patients. Such evaluation is now part of our ongoing protocol of management for patients with oesophageal cancer.

## DISCUSSION

Carcinoma of the oesophagus has a gloomy prognosis and radical treatment by surgery or radiation therapy has had little impact on survival. For surgery to be the preferred form of treatment, improved survival and/or improved palliation, and/or reduced complications, and/or cheaper costs, should be evident. Conflicting claims of benefits accruing to one mode of treatment over another continue to be made, especially with regard to improved survival, or improved quality of life.

Surgery has historically been the mainstay of treatment of oesophageal carcinoma. By careful preoperative selection, apparently improved survival can be achieved in a tiny proportion of cases. On the other hand it is clear that series treated by radiotherapy consists of 'surgical rejects' for whom operation is contraindicated by co-morbidity or by the presence of more advanced disease (e.g. tumours over 5 cm long). Despite the significantly higher proportion of larger tumours in the radiation therapy group (Table 1B) and the exclusion of 11 patients found to be irresectible at thoracotomy (Fig. 1), median survival is equivalent in the two groups—12 months—and comparable to many other series [2–4, 6].

Quality of life has not commonly been studied in this disease and is not directly addressed in this paper, nor has it been formally evaluated in these patients. However, by looking at complications, inpatient days and ability to swallow [8], we believe that there is little difference overall in the quality of life. Where it has been studied, it appears that palliation of dysphagia and pain are comparable [10]. In our series, we have shown that the quality of life for those with strictures not associated with recurrence was excellent compared to those with strictures due to recurrence [8].

The image of radiation is that of a high cost, high technology modality. In this analysis, the capital costs of radiotherapy equipment have been included. Even so, radiotherapy is cost effective, as has been shown for carcinoma of the prostate or early glottic cancer [11, 12]. These studies showed significantly lesser cost for the same outcome *and* similar side-effects for radical radiotherapy compared to surgery. These studies followed a general move away from radical surgery which was probably due to its unacceptable morbidity of severe genito-urinary problems for patients surgically treated for prostate cancer and the loss of speech for patients with glottic cancer. We believe that this is the first attempt to estimate cost differentials between the two major treatment modalities for oesophageal cancer.

Costing the treatment of oesophageal carcinoma is not straightforward. The costs estimated here are not the total costs of diagnosis and treatment, but are based on the differential use of units of service by the two treatment modalities. In analyses such as these, average bed day costs for the whole hospital is often used; but this study identified and utilized individual components of treatment (units of service). Hospital accounting systems in Australia take account only of salaries, goods and services but make no attempt to measure the treatment process nor its outcome—the discharged patient. In contrast, in the U.S.A. the introduction of prospective payment on Diagnosis Related Groups (D.R.G.s), where the cost reimbursement is based on the treatment process of specific disease, has led hospitals to develop accounting systems that measure the treatment process and outcome relative to cost inputs [13]. The complexity of treatments for diseases such as oesophageal carcinoma which use expensive technology with increasing emphasis on multi-modality treatments may necessitate the measurement of the clinical process in conjunction with traditional financial data. It is certain that without a satisfactory and more explicit accounting system, such costing becomes imprecise and in some areas impossible. In Australia, no such accounting system yet exists in spite of the potential gains to efficient service delivery, oesophageal carcinoma being but one example.

## CONCLUSION

Carcinoma of the oesophagus is currently treated either by primary surgery or by primary radiotherapy. Each modality achieves identical survival rates. There are, however, four times more financial resources used to treat this disease by surgery compared to radiotherapy.

The importance of this difference in deciding between these two treatment strategies is not yet clear, particularly as the palliative benefits of surgery compared to radiotherapy were not formally evaluated. However, it cannot be ignored as an important factor requiring integration into decision-analysis of the treatment of a disease, particularly where the two different strategies result in equivalent and short lived survival.

## REFERENCES


1. Health Commission of New South Wales. *Cancer in New South Wales: incidence and mortality.* 1981.
2. Earlam R, Cunha-Melo JR. Oesophageal squamous cell carcinoma: I. A critical review of surgery. *Br J Surg* 1980, **67**, 381–90.
3. Earlam R, Cunha-Melo JR. Oesophageal squamous cell carcinoma: II. A clinical review of radiotherapy. *Br J Surg* 1980, **67**, 457–461.
4. Newaishy GA, Reed GA, Duncan W, Kerr GR. Results of radical radiotherapy of squamous cell carcinoma of the oesophagus. *Clin Radiol* 1982, **33**, 347–352.
5. Akiyama H, Tsurumara M, Kawamira T, Ono Y. Principles of surgical treatment for carcinoma of the oesophagus: analysis of lymph node involvement. *Ann Surg* 1981, **194**, 438–446.
6. Cederquist, Neber J, Bertheleen A. Cancer of the oesophagus II: therapy and outcome. *Acta Chir Scand* 1978, **144**, 233–240.
7. O'Rourke IC, Johnson DC, Tiver KW *et al.* Management of oesophageal cancer at Westmead Hospital from 1979–1985. *Med J Aust* 1988, **148**, 450–456.
8. O'Rourke IC, Tiver KW, Bull CA, Gebski V, Langlands AO. Swallowing performance after radiation therapy for carcinoma of the oesophagus. *Cancer* 1988, **61**, 2022–2026.
9. Franklin R, Steiger Z, Vaishampayan G *et al.* Combined modality therapy for esophageal squamous cell carcinoma. *Cancer* 1983, **51**, 1062–1071.
10. Stoller JL, Brumwell ML. Palliation after operation and after radiotherapy for cancer of the oesophagus. *Can J Surg* 1984, **27**, 491–495.
11. Hanks GE, Dunlop K. A comparison of the cost of various treatment methods for early cancer of the prostate. *Int J Radiat Oncol Biol Phys* 1986, **12**, 1879–1881.
12. Mittal B, Rao DV, Marks JE, Ogura JH. Comparative cost analysis of hemilaryngectomy and irradiation for early glottic carcinoma. *Int J Radiat Oncol Biol Phys* 1983, **9**, 407–408.
13. Palmer G, Wood T. Diagnosis related groups: recent developments and their adaption and application in Australia. *Aust Health Rev* 1984, **7**, 67–80.