

# Counting the Costs of Cancer Therapy

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**Abstract**—*The costs of cancer treatment were estimated for five groups of cancer patients: those with operable breast cancer receiving adjuvant chemotherapy and patients with advanced breast cancer, ovarian cancer, germ cell cancer and small cell lung cancer. Cancer treatment costs were substantial but chemotherapy cost was a relatively minor item. Methods of limiting treatment costs are identified as reducing hospital stay, encouraging outpatient administration of chemotherapy and limiting the number of supernumary investigations. The cost of different cancer treatment options should be considered when management decisions are made.*

## INTRODUCTION

CONCERN about the high and rising costs of health care has been reflected in the rapid growth in the literature on cost benefit and cost-effective analysis in health care. Conspicuous by their absence have been careful analyses of the costs of treating cancers other than leukaemia [1, 2]. The benefits of high-cost cancer treatment in patients with poor prognoses have been questioned and cytotoxic drug costs have been the focus of attention, mainly because they are so easily itemised [3-5]. In order to determine the costs of cancer treatment and how these costs may be contained in the future, we have computed the costs incurred in treating hypothetical patients suffering from stage II breast cancer, metastatic breast cancer, ovarian cancer, small cell lung cancer and germ cell cancer. In adjuvant breast cancer and germ cell cancer patients the objective of treatment is cure, while in the other patients, palliation is the primary aim.

## MATERIALS AND METHODS

Royal Prince Alfred Hospital is a 961-bed general teaching hospital, with a 30-bed medical oncology unit. In 1980, 4229 outpatient visits were made to the medical oncology clinics and 3115 intravenous cytotoxic treatments were administered. The cost per bed day, excluding drugs and investigations, is A\$175 (US\$1 = approx. \$1 Australian), and the cost of an outpatient visit, including the cost of the doctor's time and other

staff involved in running the clinic, was estimated at A\$30 per visit. The cost of delivering intravenous cytotoxic chemotherapy was estimated at A\$27 per treatment, based on the salaries of the therapy team, the number of treatments and the time spent preparing and administering treatment. The costs of cytotoxic drugs were those charged to the hospital pharmacy. While we are aware that charges vary from the actual cost, we have used the Australian Commonwealth Medical Benefits Schedule charges as a proxy for cost of laboratory investigation. The costs of surgery are difficult to determine because the aggregate of all surgical costs is spread over many different budget headings. We have used A\$6 per minute of operating time as a guide to total surgical costs, a figure reached in a careful analysis at another undergraduate teaching hospital in Sydney (Little, personal communication). The costs of radiotherapy include the initial capital costs of equipment and costs of maintaining it against its usual life span, and the number of attendances and treatments given. We have used A\$55 per radiotherapy attendance rather than cost each treatment field and a comparable figure was reached in a recent analysis of the costs of radiotherapy elsewhere in Australia [6].

Using the above figures, we have costed 5 cancer treatment protocols used commonly in this unit.

## RESULTS

*Adjuvant chemotherapy in operable breast cancer*

Following mastectomy in this institution, patients with axillary lymph node metastases

receive some form of adjuvant systemic treatment. In pre-menopausal patients this has taken the form of combination chemotherapy with cyclophosphamide, methotrexate, fluorouracil, prednisone (CMFP) for 12 months  $\pm$  oophorectomy. Post-menopausal patients may receive CMFP and tamoxifen, tamoxifen alone or no adjuvant treatment (Table 1). The drug costs make up between 19 and 27% of the total cost, depending on the treatment arm, while the costs of investigations are 2–3 times higher (Table 2). The costs of actually administering adjuvant intravenous chemotherapy also exceed the drug costs.

The costs of diagnosis and surgical treatment of breast cancer have also been estimated. In this institution the mean duration of hospital stay for a modified radical mastectomy is 14 days, and with pre- and post-operative investigations and 1½ hr of operating time these costs amount to approximately A\$3500, similar to the total cost of one year's adjuvant chemotherapy with CMFP. A modified radical mastectomy followed by 1 yr adjuvant chemotherapy will therefore cost approximately A\$6500. No post-operative chest wall radiotherapy is given routinely to these patients.

Recent studies of adjuvant combination chemotherapy in operable breast cancer have reported an approximate 10% survival advantage at 5 yr compared to surgery alone, with a higher survival seen in certain sub-groups [7]. The natural history of operable breast cancer is such that further long-term follow-up is required before the effect of

treatment on long-term survival is known and this, rather than relapse-free survival, is the ultimate aim of treatment. Nissen-Meyer has reported a similar improvement in 10-yr survival following a 6-day course of cyclophosphamide given immediately following mastectomy [8]. If combination chemotherapy does not show a significantly better survival advantage after 10 yr follow-up, the former treatment will be preferred since it is simpler and more cost-effective.

#### *Treatment of advanced breast cancer*

The management of advanced breast cancer usually involves sequential use of hormonal and/or cytotoxic chemotherapy. In pre-menopausal patients, oophorectomy is a frequently used hormonal treatment, but in post-menopausal patients additional treatment, e.g. tamoxifen, is preferred. Combination chemotherapy regimens for advanced breast cancer are numerous and we have used doxorubicin cyclophosphamide followed by vincristine, methotrexate and fluorouracil (Table 1). The costs of these policies are summed for 2 yr treatment and the drugs account for approximately 36% of the total costs (Table 2). This therapy is usually given to outpatients and the number of investigations is defined in our protocol. The costs incurred prior to entry in our advanced breast cancer study vary widely, depending on previous therapy and number of hospital admissions and investigations. Since the majority of patients with advanced breast cancer have previously had a mastectomy, A\$3500 is the

Table 1. Outline of dosage, timing and duration of treatment

Treatment	Dose	Timing of treatment	Route of administration	Cycle	Duration (months)
Cyclophosphamide	100mg/m <sup>2</sup>	days 1 – 14	p.o.	28-day	12
Methotrexate	40mg/m <sup>2</sup>	days 1 + 8	i.v.		
Fluorouracil	600mg/m <sup>2</sup>	days 1 + 8	i.v.		
Prednisone	7.5mg	daily	p.o.		
Tamoxifen	20mg	daily	p.o.	Continuous	12
Doxorubicin	50mg/m <sup>2</sup>	day 1	i.v.	21-day	6
Cyclophosphamide	750mg/m <sup>2</sup>	day 1	i.v.		
Vincristine	2mg	day 1	i.v.		
Methotrexate	50mg/m <sup>2</sup>	days 1 + 8	i.v.	28-day	18
Fluorouracil	600mg/m <sup>2</sup>	days 1 + 8	i.v.		
Vincristine	1mg/m <sup>2</sup>	day 1	i.v.	21-day	6
Cyclophosphamide	750mg/m <sup>2</sup>	day 1	i.v.		
Doxorubicin	50mg/m <sup>2</sup>	day 1	i.v.		
Chlorambucil	7.5mg/m <sup>2</sup>	days 1 – 14	p.o.	28-day	12
Cisplatin	50mg/m <sup>2</sup>	day 14	i.v.	28-day	8
Cisplatin	100mg/m <sup>2</sup>	day 1	i.v.	21-day	3½
Vinblastine	6mg/m <sup>2</sup>	days 1 + 2	i.v.		
Bleomycin	15mg	weekly $\times$ 10	i.v.		

Table 2. Breakdown of costs in different chemotherapy protocols

Tumor type	Major treatment option	Drug cost, A\$	Administration cost, A\$	Investigation, A\$	Outpatient attendance, A\$	Admission cost, A\$	Total, A\$
Breast (adjuvant)	C.M.F.P.	584	648	1120	720	—	3072
	Tamoxifen	360	—	1063	360	—	1783
	Observation	—	—	1063	360	—	1423
Breast (advanced)	AC (VMF)	2505	1215	2454	1350	—	7524
	Tamoxifen	1368	—	2207	720	—	4295
Germ cell	P.V.B.	2500	135	646	—	875	4156
Small cell lung cancer	V.C.A.	1600	270	408	300	—	2578
Ovarian cancer	Chlorambucil	136	—	1257	360	—	1753
	Chlorambucil	1086	216	1357	360	1400	4419
	+ cisplatin						

minimum likely cost of earlier treatment. Together, the total treatment costs may exceed A\$9000, depending on the allocated treatment and survival.

The treatment of advanced breast cancer is palliative, and with combination chemotherapy 50–60% of patients have a tumour response and subsequently have a median survival of 18 months [9]. Aggressive therapy has a higher response rate than single agent treatment but only modest effects on increasing overall survival. Patients most likely to benefit from combination chemotherapy are not easily identified. One question yet to be answered by clinical trials is when, in the natural history of advanced breast cancer, patients should be considered for trials of chemotherapy and whether interrupted courses of therapy given when patients are symptomatic is as efficacious (in terms of palliation and quality of survival) as prolonged chemotherapy.

#### *Germ cell cancer*

The introduction of regimens employing cisplatin, vinblastine and bleomycin (PVB) has dramatically improved the prognosis of advanced stage germ cell cancer patients. Long-term survival (? cure) can now be expected in over 60% of patients [10]. Up to five courses of PVB are usually given (Table 1), each requiring at least a 1-day hospital admission. Drug costs amount to 60% of the total and overshadow the costs of investigations, which amount to 10% of the total (Table 2). Additional maintenance chemotherapy with vinblastine for 6 months adds A\$700 to the total cost. The average hospital stay for an orchidectomy including pre- and post-operative investigations is 10 days, with a total cost of A\$2500. Of these, surgery costs A\$360, the remainder being made up by the bed cost and investigations.

A 14-day admission and 6-hr retroperitoneal node dissection results in a minimum cost of A\$4600, while abdomino-pelvic radiotherapy as an outpatient, which is an alternative approach with equivalent outcome for managing early testicular cancer, costs in the region of A\$1400.

#### *Small cell lung cancer*

Patients with 'limited disease' small cell lung cancer in this unit are treated initially with vincristine, doxorubicin and cyclophosphamide. Responding patients subsequently receive mediastinal and cranial radiotherapy and further therapy with the same or 'non cross-resistant' drugs. The drugs make up 50% of the total treatment cost, depending on the combination used, with the cost of the split-course radiotherapy to the mediastinum and brain being in the region of A\$1100. The usual cost of establishing the diagnosis of small cell lung cancer is A\$550, which includes a 2-day hospital admission. The median survival in our study from start of treatment is 54 weeks (range 32–68) and the median number of days spent in hospital from the start of treatment to death is 33 days (range 16–73 days). The reasons for hospital admissions include the administration of treatment, but usually it is for management of treatment complications or disease progression. These hospital admissions result in a cost of A\$5775 (range A\$2800–A\$12,775) excluding the cost of additional investigations and therapy.

#### *Advanced ovarian cancer treatment*

Our management policy in advanced (stage III and IV) ovarian adenocarcinoma involves sequential or combined use of chlorambucil and cisplatin. The combined cisplatin–chlorambucil arm costs 2½ times more than initial chlorambucil alone. In these patients, the diagnosis and surgical

management usually require a minimum of 14 days hospital admission, which, including 2 hr of surgery, results in a cost of A\$3500. A second-look laparotomy after 12 months treatment in responding patients requires a similar inpatient stay at similar cost. The total cost of treating a patient with initial debulking surgery followed by cisplatin/chlorambucil for a year with a second-look laparotomy is A\$11,000.

Alkylating agents result in a 40–50% response rate in patients with advanced ovarian cancer, while more aggressive chemotherapy including cisplatin has higher response rates [12]. The impact of aggressive therapy on 5-yr survival is uncertain and at present the intent of treatment is best described as aggressive palliation with 'cure' a possibility in a minority.

### DISCUSSION

The high costs of cancer chemotherapy are frequently alluded to yet few studies attempt to detail the total costs incurred in treating patients with cancer [3, 4]. This is of more than academic interest when one considers that cancer has risen from the 8th most common cause of death in the U.S.A. in 1900 to become the 2nd most common cause of death now. Cancer is an expensive disease for the community, not only because of the work-years lost (3rd commonest medical cause of loss of productive life), but also because of the cost of treatment.

We have estimated the costs that arise in managing 5 common cancers and estimated the minimum likely cost of treatment from initial diagnosis to the end of treatment or death. The greatest single expense is the occupation of a hospital bed, and a 2-week stay in hospital is equivalent to the total drug cost with our most expensive drug combination. The costs of investigations are also significant and many chemotherapy protocols require extensive pre-treatment investigations and regular investigations during therapy which are not essential for patient care. There are some recent preliminary data to suggest that symptoms alone are of more value than routine scans and X-rays as an indicator of early relapse in women receiving adjuvant chemotherapy for breast cancer [12]. This has important connotations and similar

analyses should be extended to other cancer therapy studies.

It is essential that physicians have a realistic understanding of the likely gains of cancer therapy. While there can be justification for aggressive intensive therapy in cancers when the aim of treatment is cure, similar treatment may be less easily justified for the majority of advanced cancers where palliation is the object of chemotherapy. The identification of patients likely to benefit from complex expensive and toxic therapies is one advantage of carefully conducted clinical trials.

Protocols and randomised clinical studies in advanced cancer patients must consider the financial costs of therapy as well as the quality and quantity of survival. The costs of chemotherapy are easily itemised and often appear disproportionately high as the costs of surgery and radiotherapy are not stated or easy to identify. There is a need for careful audits on the cost-effectiveness of different cancer treatment options, e.g. surgery, radiotherapy or hormonal-chemotherapy. One study has demonstrated that chemotherapy in advanced breast cancer is an effective way of achieving both palliation and a reduction in the costs of medical care [13]. This report should be validated by further such analysis.

In view of limited resources, methods must be found of limiting the costs of cancer treatment without prejudicing patient care or the progress of clinical research. Outpatient therapy is such an approach [5]. Other methods of reducing costs include limiting the number of investigations and limiting duration of hospital stay. The median length of stay for terminally ill patients in our unit is 14 days (range 1–80 days). In some cases, terminally ill patients may be better cared for in hospices, where total care costs are less than 50% of those in hospital.

In the present economic climate it is important to estimate the total cost of cancer treatment, including chemotherapy, radiotherapy and cancer surgery, with particular reference to their cost-effectiveness and impact on survival and quality of life. This paper reports an attempt to cost cancer treatment and, contrary to expectations, cancer chemotherapy is found to contribute in only a modest way to the overall costs of cancer care.

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