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Original Paper

Treatment Costs in Hodgkin's Disease: A Cost-utility Analysis

J. Norum,[1] V. Angelsen,[2] E. Wist[1] and J.A. Olsen[2]

[1]Department of Oncology, University Hospital of Tromsø, P.O. Box 13, N-9038 Tromsø; and [2]Department of Economics, University of Tromsø, N-9037 Tromsø, Norway

The aim of this study was to estimate costs of treatment for Hodgkin's disease (HD) and the outcome in health in terms of quality-adjusted life-years (QALYs), and compare these to a constructed no-treatment alternative. All 55 patients treated for HD at the oncological unit of the University Hospital of Tromsø between 1985 and 1993 were included. The total treatment costs (medication, hospital stay, hospital hotel stay, radiotherapy, travelling, loss in production, i.e. work) were retrospectively estimated for all patients. In December 1994, the 49 survivors were sent a EuroQol questionnaire recording quality of life: 42 responded. The mean quality of life score was 0.78 on a 0–1 scale, and the mean total cost of treatment was £12512. The total treatment costs were significantly higher in patients with advanced clinical stages of the disease ($P = 0.0006$), B-symptoms (fever, sweats, weight loss) ($P = 0.0027$) and relapse ($P < 0.0001$). The costs of one QALY (with production gains included and using a 10% discount rate) were estimated at £1651. When excluding production gains and using a 5% discount rate, the figures became £1327. This makes HD one of the most cost-effective malignancies to treat.

Key words: Hodgkin's disease, treatment costs, quality-adjusted life-years
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INTRODUCTION

HODGKIN'S DISEASE (HD), which was once frequently fatal, is now a highly curable disease. The vast majority of patients are cured by radiotherapy, chemotherapy or a combination of these. Currently, no stage of disease is considered beyond cure, although several patients suffer from psychological sequelae and late physical effects (i.e. nausea, vomiting, reproductive problems, dyspnoea, heart failure) [1].

For the treatment of Hodgkin's disease, there are several regimens (chemotherapy, mantle field irradiation, minor mantle field irradiation or combinations of these) available at different costs. Several of the treatment modalities may have equal efficacy, so there is a need for an economic evaluation that documents the cost-effectiveness of resources required for the treatment of patients with HD.

The aim of this study was to estimate the costs of treatment for HD in Northern Norway and outcome in health in terms of quality-adjusted life-years (QALYs) and compare these with a constructed no-treatment alternative.

Correspondence to J. Norum.
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PATIENTS AND METHODS

Patient characteristics

During the period of January 1985–August 1993, a total of 55 patients (23 women, 32 men) with HD had been treated at the Department of Oncology, University Hospital of Tromsø (UHT). 4 patients had been given their initial treatment at another institution (The Norwegian Radium Hospital (NRH)). In December 1994, the records of these patients were retrospectively analysed in terms of their sex, age, histological subgroup, clinical stage, treatment modality, clinical outcome and treatment costs. The staging and pathological subtyping were performed according to the Ann Arbour staging sytem and the Rye classification system, respectively. The chemotherapy regimens employed for stages I and II were either ChlVPP (chlorambucil, vinblastine, procarbazine and prednisone), ABOD (doxorubicin (or epirubicin), bleomycin, vincristine and dacarbazine) or ABVP (doxorubicin (or epirubicin), bleomycin, vinblastine and prednisone). Patients in stages III and IV were treated with ABOD, ChlVPP or alternating ABOD/ChlVPP regimens. 2 patients initially treated at another institution (NRH) were given mustine-containing regimens (MVPP: nitrogen mustard, vinblastine, procarbazine, prednisone; MOPP: nitrogen mustard, vincristine, procarbazine, prednisone). The MIME regimen

(methylguazone, ifosfamide, methotrexate and etoposide) was employed for recurrent disease when ABOD and ChlVPP had failed. Supradiaphragmatic stages I and II were treated with radiotherapy to mantle fields employing a 6 MV linear accelerator, either alone or in combination with chemotherapy, as outlined above. Details on treatment modalities have been previously published [2, 3].

Health care costs

The total treatment costs were calculated for all patients at 1994 prices by the Department of Finance, UHT, and converted to British pounds at the rate of £1 = NOK 10.00.

The cost of a hospital stay at the Department of Oncology was calculated at an average per diem rate of £211 (from the price list for the UHT). This was the basic cost of the stay, excluding treatment and medication costs. The rate was used even if the patient had received partial treatment at another hospital. The number of days recorded were only the days needed for the treatment of HD, and did not include prolonged stays due to other diseases/causes.

The cost of a hospital hotel stay was calculated at an average rate of £26 per night (using the 1994 annual accounts of the hospital hotel divided by the total number of visitor nights). The hospital hotel is located at the UHT, but has no medical staff. It offers outpatients a free bed and all meals during therapy, reducing overall treatment costs.

The cost of radiotherapy is £40 per treatment field, based on data from the National Insurance Administration (NIA).

The cost of chemotherapy and anti-emetic therapy is based on the price list, as of December 1994, obtained from the Pharmacy at the UHT. Due to difficulties in achieving the correct dosages for chemotherapy in all cases and courses, the standard dose for 2 m^2/patient was employed in all cases when calculating chemotherapy costs. In this manner, the comparison between different regimens was simplified and not biased by varying body surfaces and dose reductions among the patients.

In addition to these 'direct health care costs', travelling costs were included, calculated at an average of £90 per trip (according to information from the NIA). This cost may appear high, but in Northern Norway the UHT serves a population of 500000 inhabitants scattered in an arctic area of 175988 km^2 (112918 km^2 excluding Svalbard). In comparison, the size of the U.K. is 244102 km^2. Although some courses of chemotherapy were administered at local hospitals, all patients had to travel to Tromsø for radiotherapy and evaluation of the chemotherapy. Several patients also travelled with a companion, raising the travelling costs.

It should be noted that these health care costs are mainly calculated on the basis of primary data on each patient, i.e. the total costs represent an aggregation of each patient's costs as calculated from a retrospective analysis of their records.

Non-health care costs (indirect benefits)

In Norway, all employees have to pay an income-related tax to the NIA. When reported ill by their doctors, they receive an income for up to 1 year paid by the NIA. Thereafter, they undergo a rehabilitation programme and receive a reduced salary or are given a disability pension. To clarify the situation among our group of HD patients, a questionnaire concerning their social insurance status was mailed to the local offices of the NIA.

For simplicity, the usual assumption was made of taking gross income as a proxy for the value of their employment. The mean annual income among Norwegian workers in 1994 was £18250 (data from the Statistics Norway). However, as outlined below, the indirect benefits are estimated as a fraction of the patients' income.

Outcome in health

There are several types of disease-specific units of outcome. The problem is that they, by definition, are not commensurable across diagnoses. The QALY represents the most widely used non-disease-specific unit of outcome in health. It is designed to enable comparison to be made of effectiveness between health care programmes. QALYs account for improved quality of life (QoL) as well as the increase in length of life, in terms of life years gained, which follows as a consequence of an intervention.

Of the various instruments available to measure QoL, the one applied in this study is known as the 'EuroQol' instrument. The EuroQol questionnaire is a standardised non-disease-specific instrument for describing and valuing states of health developed by the EuroQol Group [4]. The state of health description system includes five dimensions (mobility, self-care, daily activities, pain and mood), and within each dimension there are three levels (no problem, moderate problem, extreme problem). The system gives 243 possible combinations, but beyond these, the states 'unconscious' and 'dead' were added, giving a total of 245 possible combinations. Based on recent surveys undertaken by the EuroQol Group [4], state of health values have been estimated for all of these possible combinations. The values range from 0 to 1, where 0 = dead and 1 = best imaginable health. The tarrifs used in this study are obtained by their use of the 'time trade off' (TTO) elicitation technique.

In addition to the respondents scoring their current state of health in terms of the EuroQol descriptive system, they were also asked to indicate their current state of health value more directly by means of visual analogue scale (VAS) introduced by the EuroQol Group. This scale is illustrated like a thermometer, ranging from 0 to 100. In this way, the respondents' evaluation of their state of health, as reported directly on the VAS scale, was compared with the values corresponding to their state of health as indirectly described by the EuroQol system.

In December 1994, 49 survivors (according to the Population Register of Norway) were sent a questionnaire in which they were asked to describe their state of health in terms of the EuroQol system (see Appendix). 42 (86%) returned the questionnaire. All patients had answered every question and could be included in the analysis. Characteristics of all of the patients are given in Table 1.

Regarding calculation of the increased survival in terms of life years gained, it is not possible to calculate this in the direct way used for calculating costs and QoL values until the 42 patients have died. Instead, the gained life years were estimated based on the judgement of a panel of experts. In the study by Angelsen [5], a panel of experts reached consensus in suggesting an estimated mean survival for untreated HD patients of 2 years, while the panel's judgement of the state of health within EuroQol's descriptive system corresponded with a QoL score of 0.14. The mean survival of patients treated for HD was estimated to be 20 years. This assumption is in accordance with the results from the 20-year MOPP follow-up study by the National Cancer Institute [6, 7].

Table 1. Patient characteristics

		Respondents ($n = 42$)	Non-respondents ($n = 7$)
Age (years)	Median	38	36
	Range	15–70	22–58
Sex	Male	24	1
	Female	18	6
Stage	I	9	2
	II	18	1
	III	11	2
	IV	4	2
B-symptoms	Yes	10	2
	No	32	5
Pathological diagnosis	LP	11	3
	MC	14	3
	NS	17	1
	LD	0	0
Treatment	Radiotherapy (RT)	10	1
	Chemotherapy (CT)	16	5
	CT and RT	16	1
Relapse		5	4
Follow-up (months)	Median	48	78
	Range	16–120	44–120

LP, lymphocyte predominance; MC, mixed cellularity; NS, nodular sclerosis; LD, lymphocyte depletion.

Social insurance status

The social insurance status was registered by means of a questionnaire authorised by NIA and sent to the local offices of the NIA in Northern Norway. Forty-five questionnaires were returned.

Statistics and authorisation

Microsoft Excel version 4.0 for personal computers was used for the final database and the Statistical Package for Social Science (SPSS) version 6.0 for statistical calculations. Patients with an unknown value for a particular variable were excluded from analysis involving that variable. Statistical comparisons between the different groups were performed employing the One-Way ANOVA. All P values are two-tailed and considered statistically significant when $P < 0.05$.

The study was authorised by the Board of Ethics of the Norwegian health region V and the NIA.

RESULTS

In December 1994, 49 of the 55 patients were alive with a median follow-up time of 52 months (range 16–120 months). 6 patients died during follow-up at varying stages of the disease (stage I:3 patients, stage II:1 patient, stage III:1 patient and stage IV:1 patient). 5 patients died of recurrent disease, with a median time of 17 months after diagnosis (range 7–66 months), and 1 of infectious disease during primary therapy. The 5-year and 10-year overall survival rates were 90% and 86%, respectively (Figure 1). A worse prognosis was associated with age over 40 years (Figure 2) and stage IV of the disease (Figure 3). The average health care costs for primary

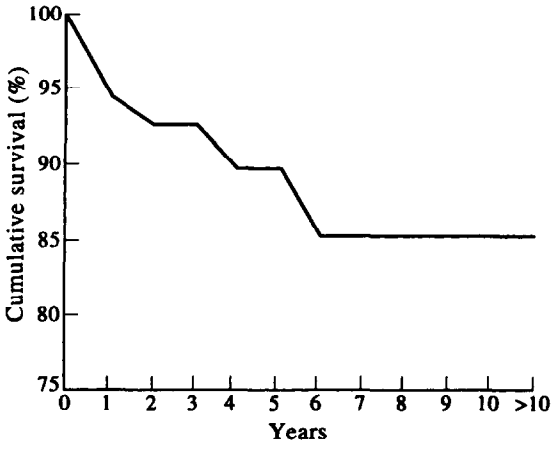

Figure 1. The overall survival rate in 55 patients treated for Hodgkin's disease at the University Hospital of Tromsø in the time period 1985–1993.

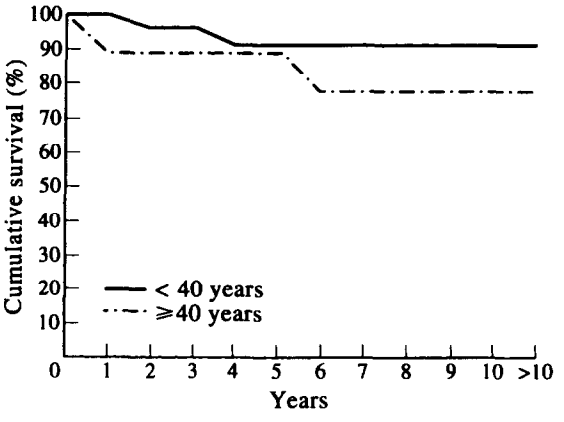

Figure 2. Overall survival rate related to age (<40 or ≥40 years) in 55 patients treated for Hodgkin's disease at the University Hospital of Tromsø in the time period 1985–1993.

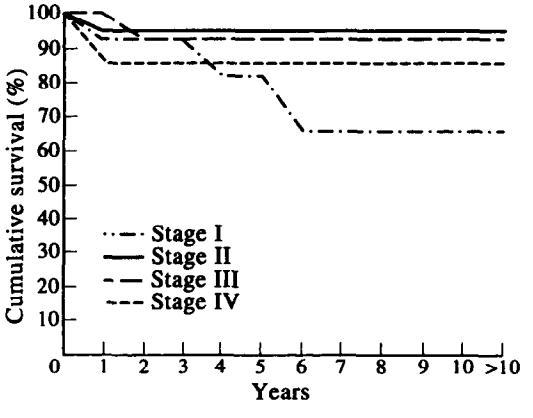

Figure 3. Overall survival rate related to clinical stage (I–IV) at diagnosis in 55 patients (stage I:14 patients, stage II:20 patients, stage III:14 patients, stage IV:7 patients) treated for Hodgkin's disease at the University Hospital of Tromsø in the time period 1985–1993.

and total treatment of HD were calculated at £8365 (range £2657–13860) and £12512 (range £2657–89200), respectively. The low cost (£2657) in 1 patient was caused by death during primary therapy. There was no correlation between primary therapy costs and stage of disease. The total health

Table 2. Treatment costs for 55 patients treated for Hodgkin's lymphoma at the Department of Oncology, University Hospital of Tromsø between 1985 and 1993

Treatment	Stage	Mean cost (£)	Range (£)
Primary			
	I	7223	2657–11853
	II	8513	3798–13860
	III	9195	6874–13344
	IV	8567	6874–10882
Total costs (primary and relapse(s))			
	I	7905	2657–18967
	II	8991	3798–13860
	III	13489	6874–34720
	IV	29837*	6874–89200

* Mean treatment cost excluding 1 case of autologous bone marrow transplantation was £19943.

care costs, however, were significantly higher in more advanced stages of the disease ($P = 0.0006$), due to a higher frequency of relapse among patients. There was one relapse (1/14) in stage I, one (1/20) in stage II, four (4/14) in stage III and six (6/7) in stage IV. Details on health care costs are shown in Table 2. The increase in costs in stage IV was partly caused by autologous bone marrow transplantation (ABMT) in 1 patient (the mean cost was £19943 if this patient was excluded).

There were notable differences in cost between the various chemotherapy regimens. The costs were £175 with ChlVPP, £663 with ABVP, £811 with ABOD, £971 with EBVP, £1016 with EBOD and £2162 with MIME per month (chemotherapy only).

Hospital stay and chemotherapy costs account for 36% and 31% of the health care costs for primary disease. For primary and relapse(s) (excluding ABMT), the figures were 36% and 35%, respectively. Details are shown in Table 3. The ABMT patient was excluded from analysis because, although the total cost of ABMT was known, the exact cost of the hospital stay was uncertain.

Table 3. The relative importance of five health care cost items (chemotherapy, radiotherapy, hospital hotel stay, hospitalisation and travelling) for an average patient. The distribution is shown in both the primary situation and the primary and relapse situation

	Type of cost	Cost/ patient (£)	Percentage
Primary disease	Chemotherapy	2591	31
	Radiotherapy	1271	15
	Hotel stay	461	6
	Hospital stay	2995	36
	Travelling	1047	12
Primary and relapse(s)*	Chemotherapy	3891	35
	Radiotherapy	1453	13
	Hotel stay	522	5
	Hospital stay	4042	36
	Travelling	1316	12

* The autologous bone marrow transplantation in 1 patient was excluded.

Patients with B-symptoms ($P = 0.0027$) and recurrent disease ($P < 0.0001$) had significantly higher health care costs when compared with the others. Half (7/14) of the patients with B-symptoms relapsed. The mean treatment cost in patients with B-symptoms was £21334 (range £6874–89200) compared with £9500 (range £2657–34720) among those without. The corresponding figures among relapsing and non-relapsing patients were £27929 (range £6874–89200) and £8210 (range £2657–13860), repectively.

There were no correlations between treatment costs and age at diagnosis, sex, histological subgroup, delay in diagnosis, where the patients lived, or whether the patient received a disability pension or not.

Only 11 of the possible 245 combinations on the EuroQol questionnaire were used by the patients. The state of health values, as estimated by EuroQol, appeared to be close to the values reported by the respondents. The correlation is shown in Table 4. The mean QoL value according to the five dimensions in the EuroQol questionnaire was 0.78, while the mean score as plotted on the VAS was 0.77. There were only minor differences across the various stages of disease. The mean scores were: 0.77 (VAS 0.76) in stage I, 0.73 (VAS 0.73) in stage II, 0.85 (VAS 0.80) in stage III and 0.81 (VAS 0.83) in stage IV. These findings reveal a remarkably close correlation between the EuroQol questionnaire and the direct VAS measuring of QoL ($P < 0.001$).

Comparing QoL values, 10-year overall survival rates and the total treatment costs, the cost-effectiveness of treating different stages of HD was estimated (Table 5). At 10 years follow-up, the indicated cost (not discounted) for stage IV of the disease was more than twice the cost for stages I–III. However, this cost was considered acceptable. Even treatment employing high-cost therapy, such as ABMT and the MIME regimen, appear cost-effective. The mean total treatment cost in 4 patients treated with the MIME regimen was £33148 and the mean QoL 0.65. The total treatment cost in 1 patient treated with ABMT was £89200 and the QoL 0.53. Employing a cut-off level of £20000 per QALY, a median gain in survival of 8.5 and 2.5 years in the ABMT and MIME

Table 4. The correlation between the state of health values, as estimated by EuroQol, and the values reported on a visual analogue scale (VAS) by respondents

EuroQol code	Number of patients	State of health value (0–1)	Mean VAS score (0–100)	Range
11111	19	1.00	88	70–100
11211	1	0.80	50	50
11112	7	0.75	76	40–98
11121	2	0.75	78	75–80
11221	2	0.60	80	75–85
11212	2	0.57	68	60–75
11122	4	0.53	81	75–90
21221	1	0.47	40	40
21212	1	0.44	50	50
21222	2	0.33	50	50
21331	1	0.29	20	20

Table 5. The cost-effectiveness of treating different stages of Hodgkin's disease is indicated by comparing quality of life (QoL), 10-year survival rate and total treatment costs for stages I–IV; estimates were not discounted

Stage	Number of patients (*n*)	(1) Total cost (£)	(2) QoL (0–1)	(3) 5-year survival* (0–1)	(4) 10-year survival* (0–1)	(5) [(1)/10×(2) × (4)] (£/years)
I	14	7905	0.77	0.83	0.66	1555
II	20	8991	0.73	0.95	0.95	1296
III	14	13489	0.85	0.93	0.93	1706
IV	7	29837	0.81	0.86	0.86	4283

* Survival according to Kaplan–Meier.

groups make the treatment cost-effective. At evaluation, the median follow-up in our study was 14 years and 32 months in the ABMT and MIME groups, respectively.

Data from the NIA were received for 45 of the 49 survivors and revealed that 18 (40%) were in the general workforce, 12 (27%) followed a rehabilitation programme, 8 received a disability pension, and 7 were reported ill. 5 of the 7 patients had been reported ill due to HD and 5 of 8 had received a disability pension due to this malignancy.

There was no correlation between the rehabilitation programme and age, sex, histological subtype, stage of disease, treatment modality or relapse. There was a significant correlation, however, between disability pension and the patients' age ($P = 0.0015$). The median age at diagnosis in the group given a disability pension was 58 years (range 40–66 years) compared with 36 years (range 15–66 years) among the rest. No correlation between disability pension and sex or stage of disease was found.

Based on the data from the NIA, the median age in the group (37 years) and the fact that younger patients with HD have a better prognosis (Figure 2), a total of 65% of the patients were estimated to return to the workforce for a mean period of 20 years. The 'human capital' was then calculated employing the mean income of Norwegian workers of £18250, which over 20 years was £237250 per patient (not discounted). Due to the fact that these patients could be replaced in the labour market by unemployed people, the real production gain was estimated to be 10% of the human capital [8]. Furthermore, estimation of the 'indirect benefits' is based on the argument that the appropriate amount to be subtracted from the health care costs in a cost-effectiveness or cost-utility analysis is the fraction of this increased production that is likely to end up as increased health care findings. Olsen [9] suggests that for OECD (Organisation for Economic Cooperation and Development) countries, this figure is 10%. Hence, the production gain in this analysis was estimated at 1% of the human capital value.

Although we would argue that the current study has followed a sound methodology for cost-utility analysis, we have based our model on different epidemiological and economic assumptions. A sensitivity analysis on the survival and QoL in untreated patients, the percentage of patients returning to the workforce and the time period spent as part of the workforce are shown in Table 6. Changes in the labour market, causing only 50% of patients to return to the workforce for 15 years or 75% for 20 years, showed only small variations in cost per QALY. The variations would be lower if the production gain was discounted. The same findings were revealed by doubling the survival of untreated patients or improving the QoL of these patients from 0.14 to 0.50. The major factor influencing cost-effectiveness was QoL among survivors in the treatment group. An improvement in median survival of 25 years and a QoL of 0.90 lowered the cost per QALY from £795 to £549. Correspondingly, a lowered QoL of 0.60 and a 20-year median survival raised the cost to £1041. Thus, money can obviously be saved by improving QoL in the survivors of HD.

Concerning the economic assumptions, there are disagreements in the literature on how to handle some of the methodological issues that appear to have important implications for the final cost/QALY figure. Comparisons of cost/QALY are therefore difficult to make when analyses have been based on different assumptions and methodologies. Hence, rather than reporting one final cost/QALY figure, we have chosen to present several figures depending on the choice of two controversial variables: the discount rate and the inclusion of production gains. In Table 7, the columns labelled (4) and (5) show different cost/QALY figures (range £795–1803) depending on two different cost bases: health care costs only or 'net social costs'. The latter involve subtracting production gains from the health care costs. The different figures under each column depend on the chosen discount rate.

The various cost/QALY figures that emerge from Table 7 are interesting for at least two reasons. Firstly, for the specific purpose of the current paper, we note that absolute numbers are relatively small, which implies that the cost per QALY gained from treating HD patients is low. Secondly, the table shows an important methodological lesson for future studies, namely that the relative cost-effectiveness of health care programmes crucially depends on the choice of the discount rate, as well as the extent to which production gains are accounted for.

DISCUSSION

In this article, the results of an economic evaluation have been presented for the treatment of HD in Northern Norway over the time period 1985–1993. The cost-utility analysis was performed comparing these patients with a constructed no-treatment alternative. It may be argued that no treatment is not acceptable in HD. However, this is a simple way of performing a cost-utility analysis that is frequently employed and therefore chosen for this study. A non-disease-specific questionnaire (EuroQol) designed to assess the quality of life was applied. The study included all patients treated for HD at the oncological unit of the UHT for both primary and secondary disease.

The treatment regimens employed in this study were according to the recommendations from the Norwegian Lymphoma Group (NLG). They are all up-to-date regimens fre-

Table 6. A sensitivity analysis documenting the variance in cost per QALY of different epidemiological factors on survival and QoL in untreated patients, percentage of patients returning to the workforce and the time period in workforce; all costs were not discounted

Variables		Production gain (£)	QALYs gained (years)	Cost per QALY (£/years)
Returning to workforce	50% for 15 years	1369		861
	65% for 20 years	2373		795
	75% for 20 years	2738		771
No-treatment survival	2 years with QoL 0.14		15.3	795
	4 years with QoL 0.14		15.0	811
	2 years with QoL 0.28		15.0	811
Treatment survival	20 years with QoL 0.78		15.3	795
	25 years with QoL 0.90		22.2	549
	20 years with QoL 0.60		11.7	1041

When varying several factors at a time, the cost per quality-adjusted life-year (QALY) ranged from £532 to £1155. QoL, quality of life.

Table 7. A cost-utility analysis of 55 patients treated for Hodgkin's disease at the University Hospital of Tromsø

Discount rate (%)	(1) Health care costs (£)	(2) Production gains (£)	(3) QALYs (years)	(4) (1)/(3) (£)	(5) [(1)−(2)]/(3) (£)
0	14539	2373	15.3	818	795
5	13804*	1580	10.4	1327	1175
10	13165*	1110	7.3	1803	1651

* The health care costs of relapse (£4147) occur at a mean time of 24 months after primary diagnosis and are therefore discounted. The health care cost of 10 years follow-up (21 visits, £96.50/visit) is also discounted. QALY, quality-adjusted life-years.

quently employed in oncological centres. Since health resources tend to be limited, an economic evaluation of the various treatment modalities is important to help in the choice of treatment.

The health care cost was calculated retrospectively in this study. It may be argued that there will be costs in the future that are not taken into account in this study. However, this is somewhat balanced by the inclusion of 4 relapsing patients having their primary therapy at another institution. The majority of relapses occur within the first 2 years. In this study, there were no patients with a follow-up of less than 16 months. Prospective controlled clinical trials may be preferable for economic analysis [10], when QoL may be recorded several times to make QoL profiles possible. QoL was measured only once in this study. However, prospectively collected data from clinical trials may often not match subsequent care delivered routinely. This is accounted for in this study.

Radiotherapy accounts for 15% of the initial health care costs and only 13% of total costs (Table 3). This is achieved by administration of standard radiotherapy (1.8 Gy for 23 doses) in stages I and II in an outpatient (patients living at the hospital hotel) setting. If the patients had been treated as inpatients, the primary therapy cost would have been significantly higher in stages I and II compared with stages III and IV.

Chemotherapy and hospital stay are the main contributors to health care costs (71%) in this survey. There were notable differences in cost between the various chemotherapy regimens employed in HD. The costs varied from £175 for ChlVPP to £2162 for MIME per month (chemotherapy only). Costs can be saved initially by employing the ChlVPP regimen. However, side-effects, QoL, relapse and survival have to be considered before any changes in the standard therapy are made. Relapse causes a significant increase in health care costs, and the money initially saved can easily be lost due to an increase in relapse frequency. The MIME regimen, and ABMT are high cost therapies, particularly ABMT. The total cost (medication, hosptial stay, travelling) per month for the MIME regimen was £3722 compared with £859 and £1527 for the ChlVPP and ABOD regimens, respectively. Methylguazone was the most expensive agent within the MIME regimen. However, the excellent treatment results in HD make even the MIME regimen and ABMT appear cost-effective [11].

The correlation between the directly measuring VAS and the EuroQol values was statistically significant in this study, making the EuroQol questionnaire seem applicable in valuing QoL. However, this correlation should be confirmed in further studies before a general conclusion can be drawn.

Because people have distinct preferences for delaying costs and bringing forward benefits, it is not enough to simply add total costs and benefits over time [12], and to take into account this time preference in economists' parlance, the discounting of costs and benefits is necessary. This reflects the declining importance of the individual's decision-making occurring further and further into the future, by reducing their value by a given percentage for each year ahead of when they are expected to occur. The discount rate has been debated. Usually a discount rate of between 5 and 10% is used [10, 13, 14]. In this study, three alternatives have been visualised, employing discount rates of 0, 5 and 10%.

The focus on indirect costs of illness to society through the

losses/gains of working days has been an area of much debate. A recent study has shown that even if lost working time is to be included as a cost, the value placed on it should be lower than that used in previous studies [8]. The traditional human capital approach will grossly exaggerate the true production gains from treatments for countries in which sick workers can be replaced by fit and currently unemployed individuals. A more reliable estimate is called 'the friction cost method' [8], which is a hypothetical exercise that would try to estimate the real production gains from treating the 55 HD patients in this study. However, a simple 'estimate' would be 10% of the human capital figure. Furthermore, what matters to the health service is the fraction of the increased production that is likely to result in increased health care funding. Based on the assumption made by Olsen [9], we suggest that 10% of the true production gains (i.e. the friction cost estimate) would manifest itself as increased health care.

The cost of one QALY ranges from £795 to £1803, depending on which assumptions are made with respect to the discount rate and the inclusion of indirect benefits. In general, the lower the discount rate and the higher the indirect benefits, the more favourable becomes the intervention in terms of cost per QALY gained. There is increasing empirical evidence that for health care programmes, a 10% discount rate is a better reflection of people's preferences than the use of a 5% rate [15]. Using this rate, as well as taking account of indirect benefits, a conservative estimate would give the result of £1651 in cost per QALY gained. If the most widely used rate of 5% is applied, and no account is made for production gains, the result would be slightly lower, £1327. In one study, Angelsen [5] reported on several malignancies (breast cancer, colon cancer, lung cancer, non-Hodgkin's lymphoma, HD, prostate cancer, gastric cancer, oesophageal cancer and testicular cancer) and HD had the second most favourable cost per QALY (with testicular cancer having the first). Several studies have documented the cost of one QALY in different diseases. In 1985, Williams [16] published a cost per QALY for surgical treatment of angina pectoris ranging from £1040 to £12600, depending on the location and number of arterial stenoses. In 1993, Smith and colleagues [17] reported a cost per QALY employing 5-fluorouracil/levamisole for Dukes' C colon cancer of US $11725. In breast cancer, Hillner and Smith [18, 19] reported a cost per QALY (in 1989) of endocrine therapy in premenopausal women of US $57800 in oestrogen receptor (ER)-negative tumours and US $4330 in those who were ER positive. In 1992, Epstein [20] suggested a cost per QALY of about US $30000 as an acceptable cut-off point for medical treatment in general. Our data document the treatment of HD as being far below this limit. In many cases, such as gastric cancer, high-cost regimens are not economically justified [21]. However, in HD even ABMT in relapsing patients is reported to be below the limit, with a cost of US $26200 [11].

In conclusion, the treatment of HD is one of the most cost-effective treatments in cancer. A cost of one QALY of £795–1803 can be achieved. In the future, this cost may be even lower, with increases in outpatient treatment and a change in standard therapy towards low-cost chemotherapy regimens.

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APPENDIX

The EuroQol Questionnaire

Mobility

1. No problem walking about ☐
2. Some problem walking about ☐
3. Confined to bed ☐

Self-care

1. No problem with self-care ☐
2. Some problem with washing and dressing ☐
3. Unable to wash and dress self ☐

Daily activities

1. No problem performing daily activities (e.g. work, study, housework, family and leisure activities) ☐
2. Some problem performing daily activities ☐
3. Unable to perform daily activities ☐

Pain/discomfort

1. No pain or discomfort ☐
2. Moderate pain or discomfort ☐
3. Extreme pain or discomfort ☐

Mood

1. Not anxious or depressed ☐
2. Moderately anxious or depressed ☐
3. Extremely anxious or depressed ☐