Volume 13 • Number 6 • 2010
VALUE IN HEALTH

The Unit Costs of Inpatient Hospital Days, Outpatient Visits, and Daycare Treatments in the Fields of Oncology and Hematology

Siok Swan Tan, PhD, Chantal W. M. van Gils, MSc, Margreet G. Franken, MSc, Leona Hakkaart-van Roijen, PhD, Carin A. Uyl-de Groot, PhD

Erasmus Universiteit Rotterdam, Institute for Medical Technology Assessment, Rotterdam, The Netherlands

ABSTRACT

Objectives: Many economic evaluations are conducted in the fields of oncology and hematology, partially owing to the introduction of new expensive drugs in this field. Even though inpatient days, outpatient visits, and daycare treatments are frequently the main drivers of total treatment costs, their unit costs often lack generalizability. Therefore, we aimed to determine the unit costs of inpatient hospital days, outpatient visits, and daycare treatments specifically for oncological and hematological diseases in The Netherlands from the hospital's perspective.

Methods: Unit costs were collected from 30 oncological and hematological departments of 6 university and 24 general hospitals. Costs included direct labor and indirect labor, hotel and nutrition, overheads and capital. Ordinary least squares regression models were constructed to examine the degree of association between unit costs and hospital and hospital department characteristics. All costs were based on Euro 2007 cost data.

Results: At university hospitals, the unit costs per inpatient day were determined at €633 in oncological and €680 in hematological departments. At general hospitals, the mean costs per inpatient day were €400. Unit costs for inpatient hospital days, outpatient visits. and daycare treatments equalled the relative ratio 100:21:44. Direct labor costs were the major cost driver and the type of hospital (university, yes/no) was a strong predictor of unit costs.

Conclusions: The present study provided unit costs for inpatient hospital days, outpatient visits, and daycare treatments in the fields of oncology and hematology. The results may be used as Dutch reference unit prices in economic evaluations assessing oncological and hematological diseases.

Keywords: daycare treatment, hematology, inpatient hospital day, oncology, outpatient visit, reference price, unit cost.

Introduction

The number and variety of treatment options for oncological and hematological diseases have rapidly increased in the past decades. The introduction of new expensive drugs in this field has caused hospital budgets in Western countries to be continuously under pressure. Therefore, the need arose to assess these drugs in terms of their costs and benefits [1–5]. In The Netherlands, pharmacoeconomic evidence is required after 3 years of initial usage in daily practice to receive additional funding for expensive inpatient drugs on top of the fixed hospital budget [1,2]. Consequently, many economic evaluations are conducted in the fields of oncology and hematology.

Inpatient hospital days, outpatient visits, and daycare treatments have proven to be important cost drivers in economic evaluations determining the costs of alternative treatment options in the management of oncological and hematological diseases. Their unit costs should be accurate because they can markedly affect the results of an economic evaluation [6,7]. Nevertheless, clear information disseminated to the public on the unit costs of inpatient hospital days, outpatient visits, and daycare treatments is lacking [7–9]. In the current practice of economic evaluations, unit costs are usually calculated from the specific health-care providers at which the economic evaluation is performed (among others: [10–12]). These unit costs often lack generalizability because health-care providers participating in economic evaluations may not be representative of the overall treatment patterns in a country [7–9]. To guarantee generalizability, the ideal unit prices are established from large, diverse populations, which require data from multiple sources [13].

One earlier study has determined the unit costs of inpatient hospital days in The Netherlands [7]. Oostenbrink et al. [7] collected unit costs from 10 university and 12 general hospital departments, of which 3 concerned the ear–nose–throat specialty, 7 concerned internal medicine, 1 concerned gynecology, 2 concerned hematology, 4 concerned oncology, 2 concerned pulmonary, and 3 concerned surgery. These unit costs were determined to be €396 in university hospitals and €282 in general hospitals (adjusted to 2007). The results of this study were used to develop reference prices for inpatient hospital days in The Netherlands and contribute to the comparability and generalizability of economic evaluations [7,8].

Nevertheless, the reference prices developed by Oostenbrink et al. [7] may not be sufficiently distinctive for use in the fields of oncology and hematology because they are determined for use at any medical specialty. Factors influencing the potential differences between the unit costs at any medical specialty and the unit costs in the fields of oncology and hematology may include the patient case-mix and medical practice patterns (e.g., number of beds and the employment of an intensive care unit) [7,9,10,14,15]. Therefore, the primary aim of the present study was to determine the unit costs of inpatient hospital days, outpatient visits, and daycare treatments specifically for oncological and hematological diseases in The Netherlands from the hospital's perspective.

The results of the obtained unit costs may give rise to the question which factors are responsible for the differences in costs between hospital departments. Therefore, the current study additionally aimed to identify associations between collected

Address correspondence to: Siok Swan Tan, Erasmus Universiteit Rotterdam, Institute for Medical Technology Assessment, PO Box 1738, 3000 DR Rotterdam, The Netherlands. E-mail: tan@bmg.eur.nl

10.1111/j.1524-4733.2010.00740.x

1098-3015/10/712 712–719

descriptive hospital and hospital department characteristics and the obtained unit costs.

Methods

Total costs of inpatient hospital days, outpatient visits, and daycare treatments were determined separately for university and general hospitals. For university hospitals, a further distinction was made between oncology and hematology departments. For general hospitals, no distinction was made between oncology and hematology unit costs because oncology and hematology patients are often admitted to general internal medicine departments.

Total cost estimates were determined by the identification of resource use and unit costs of the following cost components: direct labor of medical specialists, residents, nurses and administrative staff; indirect labor of clinical and nonclinical departments (e.g., laundry and cleaning); hotel and nutrition; overheads (general expenses, maintenance and energy, rent and leasing) and capital (depreciation of inventory and interest). Costs of medical imaging services, laboratory services and medications were explicitly excluded from this study, because they are considered to be highly dependent on the disease and treatment strategy under consideration and often explain total cost differences between alternative treatments in economic evaluations.

Unit costs were calculated using the microcosting methodology, because this methodology provides cost estimations that most accurately reflect actual costs by identifying all relevant cost components at the most detailed level [6,16]. All costs were based on Euro 2007 cost data. Where necessary, costs were adjusted to 2007 using the general price index from the Dutch Central Bureau of Statistics [17].

Recruitment of Hospitals

A sample of university and general hospitals was identified which was representative of the overall practice setting and treatment patterns in The Netherlands. For oncology, this concerned departments which participated in the randomized phase III clinical trial investigating sequential versus combination chemotherapy with capecitabine, irinotecan, and oxaliplatin in advanced stage III/IV colorectal cancer carried out by the Dutch Colorectal Cancer Group [18]. The hematological departments were involved in the randomized phase III study on the effect of thalidomide combined with adriamycin, dexamethasone, and high-dose melphalan performed by the Dutch hemato-oncology association (HOVON) in patients <65 years old with previously untreated multiple myeloma (HOVON 50) [19].

Standardized Reporting Templates

At each of the qualified hospital departments, one medical specialist was asked personally by the investigators whether he/she would like to participate in the study. Using standardized reporting templates, the participating medical specialists were asked to provide resource use information retrospectively, based on best estimations and separately for inpatient hospital days, outpatient visits, and daycare treatments. Resource use information included the direct labor minutes spent by medical specialists, residents, nurses, and administrative staff attributable to an average patient. Resource use of direct labor was valued with standardized unit costs per minute, which equalled the normative income (including social premiums, fees for irregular working hours, and the costs of replacement during illness) divided by the number of workable minutes per year. Normative incomes were based on collective labor agreements. Because medical specialists of general hospitals work in independent corporations and are not on the payroll of the hospital, the normative income for these medical specialists are based on a national rate that also includes overhead costs. Subsequently, their unit costs are substantially higher than those for medical specialists of university hospitals (€2.50 vs. €1.46 per minute). Therefore, the normative income of university hospitals (€1.46 per minute) was used to value medical specialists' time at both university and general hospitals.

Annual Accounts

The annual accounts of the year 2006 of the hospital departments were acquired to obtain input data for the cost calculation of indirect labor, hotel and nutrition, overheads and capital. Annual costs of hotel and nutrition were divided by the annual number of inpatient hospital days to be able to appoint hotel and nutrition use to inpatient hospital days. Annual costs of indirect labor, overheads and capital were divided by the annual costs of patient-related care. Subsequently, this "mark-up percentage" was multiplied by the summed daily costs of direct labor and hotel and nutrition.

Sensitivity Analyses

To determine the uncertainty of the obtained cost estimates for university as well as general hospitals, one-way sensitivity analyses were carried out by varying the resource use and unit cost values of the individual cost components between 50% and 150%. Furthermore, at six (random) general hospital departments, one nurse was additionally asked to provide resource use data on daycare treatments to verify the information obtained from medical specialists.

Statistical Analyses

In addition to descriptive statistics, one-way analyses of variance with and without post hoc testing (type Bonferroni) were used to investigate cost differences between hospitals. Besides, all hospital departments were included in an ordinary least squares (OLS) regression analysis to explore the degree of association between total costs (dependent variable) and collected hospital and hospital department characteristics (explanatory variables). Hospital characteristics included "type of hospital" (university, yes/no), "number of beds at the hospital" and "number of inpatient days per year." Department characteristics involved "number of medical specialists" in combination with "number of beds at the department" and "number of patients per day" for inpatient hospital days, "number of visits per day" and "mean duration of a visit" for outpatient visits, and "number of beds at the daycare treatment" and "number of patients per day" for daycare treatments. Statistical analyses were conducted with the statistical software programmes SPSS for Windows version 15.0 (SPSS Inc., Chicago, IL).

Results

For university hospitals, the medical specialists of 3 oncology departments (UH1-3) and 3 hematology departments (UH3-5) were willing to cooperate. For general hospitals, a total of 24 departments (GH1-24) agreed to contribute. During the course of the data collection, one department (GH-24) was unable to provide detailed resource use information on inpatient hospital days. Furthermore, three departments (GH-9, GH-13, GH-24) were unable to provide detailed resource use information on outpatient visits and three departments (GH-7, GH-14, GH-22) on daycare treatments. Therefore, these departments were excluded from further analyses.

Table 1 Inpatient hospital day: cost distribution per university hospital

	Oncology					Hematology				
Hospital ID	UH-1	UH-2	UH-3	Mean	Standard deviation	UH-3	UH-4	UH-5	Mean	Standard deviation
Number of beds at the hospital (n)	953	882	1221	1019	179	1221	1042	733	999	247
Annual number of inpatient days at the hospital (n × 1000)	213	138	306	219	84	306	238	164	236	71
Number of medical specialists at the department (n)	12	8	21	14	7	13	9	6	9	3
Number of beds at the inpatient department (n)	20	16	42	26	14	16	16	19	17	2
Number of patients per day at the inpatient department (n)	18	16	32	22	9	16	15	19	17	2
Direct labor (€)	281	293	370	314	48	351	343	295	330	30
Medical specialists	83	79	169	110	51	136	90	110	112	23
Residents	58	65	65	63	4	65	59	46	57	10
Nurses	126*	132	123	128	6	142	178	125	148	27
Administrative staff	14	16	12	14	2	8	17	13	13	4
Indirect labor (€)	101	163	134	133	31	128	141	123	131	9
Hotel and nutrition (€)	64	74	85	74	11	85	111	98	98	13
Overheads (€)	59	87	80	76	14	77	90	79	82	7
Capital (€)	34	40	35	36	3	34	49	35	39	8
Total costs (€)	540	656	704	633	85	675	734	630	680	52

*Missing value.

Inpatient Hospital Days

Table 1 presents the cost distribution for inpatient hospital days per oncology and hematology department at university hospitals. Unit costs at hematology departments varied between €630 and €734 (n = 3) and those at oncology departments between €540 and €704 (n = 3; $P = 0.469$). Both the number of beds and the number of patients per inpatient day were slightly, but not significantly, higher at oncology departments. No significant cost differences of individual cost components were found between the oncology and hematology departments.

Table 2 shows the cost distribution for inpatient hospital days at general hospitals. Unit costs at general hospitals amounted to €400 (range: from €296 to €556; n = 23) and were about 39% lower than those at university hospitals ($P < 0.001$). In all hospitals, direct labor costs were the major cost component and ranged from 45% to 59%. Nurses were the greatest attributors to the direct labor costs (between 25% and 67% of direct labor costs).

Outpatient Visits

Table 3 presents the unit costs of outpatient visits at university hospitals separately for oncology and hematology. Total costs per outpatient visit ranged from €99 to €132 at oncology departments (n = 3) and from €125 to €158 at hematology departments (n = 3; $P = 0.212$). The number of outpatient visits per day per medical specialist was slightly, but not significantly, higher at oncology departments.

Table 4 summarizes the unit costs of outpatient visits at general hospitals. Unit costs at general hospitals were €86 (range: from €45 to €193; n = 21) and were about 34% lower than those at university hospitals ($P = 0.008$). At all hospitals, direct labor costs were the most important cost driver, with medical specialists as the greatest contributor (between 50% and 89% of direct labor costs).

Daycare Treatments

Table 3 also presents the unit costs of daycare treatments at university hospitals separately for oncology and hematology. Unit costs at hematology departments were €305 (range: from €276 to €328; n = 3) and approximately 11% higher than those at oncology departments (€276; range: from €250 to €314; n = 3; $P = 0.310$). The number of beds at the daycare treatment was slightly, but not significantly, higher at oncology departments.

Table 4 summarizes the unit costs of daycare treatments at general hospitals. Unit costs at general hospitals amounted to €176 (range: from €96 to €382; n = 21) and were about 39% lower than those at university hospitals ($P = 0.001$). At all hospitals, direct and indirect labor costs accounted for about 50% and 18% of the total costs. Nurses were the greatest attributors to the direct labor costs (50% of direct labor costs). The share of medical specialist costs was higher at university (34% of direct labor costs) than at general hospitals (21% of direct labor costs; $P = 0.001$).

Sensitivity Analyses

For all unit costs, the greatest variation in the total costs was found when direct labor minutes of either medical specialists or nurses was altered, but the deviation was limited to ±4–23%. For the cost calculation of hotel and nutrition, changing the number of inpatient hospital days per year resulted in a variation in the total costs of ±5–8%. For the cost calculation of indirect labor, overheads or capital, total costs deviated to only ±3–11% when the respective mark-up percentages were altered.

At six general hospital departments, one nurse was additionally asked to provide resource use data on daycare treatments to verify the information obtained from medical specialists. No significant differences were found between the resource use acquired from medical specialists and nurses ($P = 0.530$).

OLS Regression

Table 5 shows the models of the OLS regression that were constructed to examine the degree of association between total costs and hospital and hospital department characteristics. For inpatient hospital days, model 1a included all associated characteristics, of which only "type of hospital" ($P = 0.002$) and "number of patients per day" ($P = 0.107$) were associated with total costs. When the nonsignificant variables were left out (model 1b), using a cutoff value of $P > 0.200$, "number of patients per day" lost its significance. Model 1c included "type of hospital" only and was able to explain 72% of total costs. The university hospital type was associated with an increase in costs of €256 ($P < 0.001$).

For outpatient visits, model 2a included all associated characteristics, of which only "type of hospital" ($P = 0.037$) and

Table 2 Inpatient hospital day: cost distribution per general hospital

Hospital ID	GH-1	GH-2	GH-3	GH-4	GH-5	GH-6	GH-7	GH-8	GH-9	GH-10	GH-11	GH-12	GH-13	GH-14	GH-15	GH-16	GH-17	GH-18	GH-19	GH-20	GH-21	GH-22	GH-23	Mean	SD
Number of beds at the hospital (n)	600	1014	627	367	410	541	233	726	582	516	339	369	242	397	745	754	673	1035	390	275	925	613	576	563	231
Annual number of inpatient days at the hospital (n × 1000)	14	242	137	72	90	166	61	185	151	132	77	68	50	71	171	184	144	253	115	53	167	129	135	125	62
Number of medical specialists at the department (n)	3	5	2	4	2	2	1	2	3	7	2	2	2	3	4	7	5	4	1	2	4	6	3	3	2
Number of beds at the inpatient department (n)	22	36	18	28	8	26	12	25	24	21	19	29	24	15	19	25	30	28	11	22	16	28	29	22	7
Number of patients per day at the inpatient department (n)	20	34	18	24	8	26	12	25	24	21	19	25	24	13	16	20	10	25	10	22	16	25	26	20	6
Direct labor (€)	189	224	180	318	194	199	248	164	160	221	186	250	169	260	203	244	215	180	237	185	260	201	197	212	38
Medical specialists	41	77	58	131	37	40	175*	28	27	62*	110	128	29	75	31	68	55	20	22	22	81	51	16	55	35
Residents	53	47	39	0	55	44	0	46	48	55	0	0	44	55	44	53	42	46	71	52	44	46	44	40	20
Nurses	89	96*	76	181	90	105	63	85	78	97	69	116	91	116	120	112*	105	105	134	99	127	95	132	103	27
Administrative staff	6	4	7	5	12	10	10	5	7*	6	7	5*	5	14	8	11	14	10	9	11	8	10	5	8	3
Indirect labor (€)	58	82	47	85	56	75	114	61	44	56	57	83	60	83	52	76	85	77	85	47	87	70	60	70	17
Hotel and nutrition (€)	40	34	29	36	37	64	39	24	36	24	36	42	37	29	37	37	54	31	46	30	22	41	37	37	9
Overhead (€)	40	51	41	48	36	46	53	26	26	34	38	41	32	39	33	63	47	48	60	30	41	28	39	41	10
Capital (€)	63	4	45	69	46	44	40	35	30	41	40	37	34	50	42	50	50	29	51	31	53	14	41	41	14
Total costs (€)	390	394	342	556	370	429	493	309	296	374	357	452	333	462	367	470	451	366	480	323	463	354	374	400	67

*Missing value.
SD, standard deviation.

Table 3 Unit cost of inpatient hospital day, outpatient visit, and daycare treatment at university hospitals

	Inpatient day				Outpatient visit				Daycare treatment			
	Oncology (n = 3)		Hematology (n = 3)		Oncology (n = 3)		Hematology (n = 3)		Oncology (n = 3)		Hematology (n = 3)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Number of beds at the hospital (n)	1019	179	999	247	1019	179	999	247	1019	179	999	247
Annual number of inpatient days at the hospital (n × 1000)	219	84	236	71	219	84	236	71	219	84	236	71
Number of medical specialists at the department (n)	14	7	9	3	14	7	9	3	14	7	9	3
Number of beds at the inpatient department (n)	26	14	17	2								
Number of patients per day at the inpatient department (n)	22	9	17	2								
Number of outpatient visits per day per medical specialist (n)					17	5	14	2				
Average duration of an outpatient visit (minutes)					14	4	15	0				
Number of beds at the daycare treatment (n)									19	4	12	6
Number of patients per day at the daycare treatment (n)									27	20	28	18
Direct labor (€)	314	48	330	30	74	10	89	11	133	31	143	20
Medical specialists	110	51	112	23	56	11	58	7	50	21	43	18
Residents	63	4	57	10	0	0	0	0	12	6	11	1
Nurses	127	5	148	27	11	4	19	11	55	13	59	14
Administrative staff	14	2	13	4	7	2	12	6	15	6	30	17
Indirect labor (€)	133	31	131	9	25	7	27	3	57	9	59	5
Hotel and nutrition (€)	74	11	98	13	0	0	0	0	37	5	49	6
Overhead (€)	76	14	82	7	14	3	17	2	33	4	37	3
Capital (€)	36	3	39	8	7	2	8	1	16	4	18	4
Total costs (€)	633	85	680	52	120	19	142	17	276	34	305	28

"mean duration of a visit" ($P < 0.001$) were associated with total costs. When only these variables were included in the OLS regression (model 2b), the university hospital type was associated with a cost increase of €46 ($P = 0.001$) and one additional minute of duration of a visit with a cost increase of €4 ($P = 0.001$). Model 2b was able to explain only 54% of total costs.

For daycare treatments, model 3a included all associated characteristics, of which only "number of beds at the hospital" ($P = 0.621$) and "number of medical specialists" ($P = 0.429$) were not associated with total costs. When these nonsignificant variables were left out (model 3b), using a cutoff value of $P > 0.200$, the regression analysis showed cost increases for "type of hospital," "number of inpatient days" and "number of beds at the daycare treatment," and a cost decrease for "number of patients per day". The latter analysis explained 64% of total costs.

Conclusions

Including a total of 30 hospital departments, this study is the most extensive cost assessment of unit costs for inpatient hospital days, outpatient visits, and daycare treatments in the fields of oncology and hematology in The Netherlands thus far. With respect to inpatient hospital days at university hospitals, total costs were €633 ± 85 for oncology and €680 ± 52 for hematology. Unit costs at hematology departments were approximately 7% higher than those at oncology departments ($P = 0.469$). For general hospitals, no distinction was made between oncology and hematology unit costs because oncology and hematology patients are often admitted to general internal medicine departments. Total costs at general hospitals were €400 ± 67, with direct labor costs contributing to about half of the total costs.

Oostenbrink et al. determined the unit costs of inpatient hospital days at any medical specialty. Even though they additionally included medication and blood products, Oostenbrink et al. found the unit costs of inpatient hospital days to be substantially lower than those found in our study. Total costs in their subsample of hematology (n = 2) and oncology departments (n = 4) amounted to €327 and €303, respectively (adjusted to 2007) [7]. The methodology used to derive the direct labor cost estimates of residents and nurses may partly explain this difference. Although medical specialists were asked to estimate the direct labor minutes spent per inpatient hospital day in our study, Oostenbrink et al. divided the annual costs of residents and nurses by the annual number of inpatient hospital days. The higher cost estimations in our study directly influenced overhead and capital costs, because these were determined using a marginal mark-up percentage. Nevertheless, in agreement with our results, Oostenbrink et al. found total hematology costs to be 8% more expensive than total oncology costs and observed direct labor costs to contribute to about 51% of total costs.

Our results further suggest that total costs for inpatient hospital days, outpatient visits, and daycare treatments equalled the relative ratio 100:21:44 (Tables 3 and 4), which is fairly in line with the results of other studies. Oostenbrink et al. found the relative ratio in general hospitals to be 100:17:46 (€282, €49, €128; adjusted to 2007) [8]. Van Agthoven et al., who performed an economic evaluation in patients with stage II/III multiple myeloma at the hematology departments of 2 university and 6 general hospitals, observed a relative ratio of 100:25:45 (€463, € 109, €207; adjusted to 2007) [20]. Ward et al., who compared the cost-effectiveness of different treatment options in patients with metastatic colorectal cancer in the United Kingdom, used unit costs with a relative ratio of 100:20:30 (€632, €131, €191; adjusted to 2007) [21].

Table 4 Unit cost of inpatient hospital day, outpatient visit, and daycare treatment at general hospitals

	Inpatient day (n = 23)		Outpatient visit (n = 21)		Daycare treatment (n = 21)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Number of beds at the hospital (n)	563	231	577	231	623	284
Annual number of inpatient days at the hospital (n × 1000)	125	62	127	62	137	70
Number of medical specialists at the department (n)	3	2	3	2	3	2
Number of beds at the inpatient department (n)	22	7				
Number of patients per day at the inpatient department (n)	20	6				
Number of outpatient visits per day per medical specialist (n)			21	6		
Average duration of an outpatient visit (minutes)			15	6		
Number of beds at the daycare treatment (n)					13	8
Number of patients per day at the daycare treatment (n)					19	8
Direct labor (€)	212	38	54	24	91	38
Medical specialists	60	42	38	20	19	16
Residents	40	20	0	0	5	7
Nurses	103	26	10	6	49	23
Administrative staff	8	3	5	3	18	11
Indirect labor (€)	70	17	15	6	30	14
Hotel and nutrition (€)	37	9	0	0	18	5
Overheads (€)	41	10	9	4	18	8
Capital (€)	41	14	9	5	19	9
Total costs (€)	400	67	86	36	176	68

Our OLS regression may give some indications on the factors responsible for the differences in costs between hospital departments. It was concluded that the "type of hospital" (university, yes/no) was able to predict up to 72% of the total costs for inpatient hospital days. The "type of hospital" was also a strong predictor with respect to outpatient visits, in combination with "mean duration of a visit," and regarding daycare treatments, combined with "number of inpatient days," "number of beds at the daycare treatment," and "number of patients per day". Oostenbrink et al. have also performed regression analyses but none of their independent variables showed a relationship with total costs that came near to significance.

The cost calculations on oncology and hematology each were based on data of the hospital departments of 3 of 8 university hospitals in The Netherlands. There are indications that the included departments may be accurate representatives to Dutch university hospitals. In 2006, 36% and 39% of inpatient hospital days at university hospitals were attributable to the oncology and hematology departments of our university hospitals, respectively. The average number of beds per university hospital in our sample was 966 beds, which is close to the average number of beds per university hospital in The Netherlands (997 beds) [17]. Besides, the university hospitals in our study were located at different regions of the country.

Although we faced some missing data during the course of the data analyses, the extent to which data were missing was limited. Because hospitals in The Netherlands are obliged to give details on a predetermined list of cost components by means of their publicly available annual accounts, no data were missing on indirect labor, hotel and nutrition, overheads and capital. Regarding direct labor minutes, six hospitals (GH-7, GH-9, GH-13, GH-14, GH-22, and GH-24) were unable to provide detailed resource use information on inpatient hospital days and/or outpatient visits and/or daycare treatments and were therefore excluded from the individual analyses. Of the remaining oncology departments, only 7.8% of the required items in university hospitals and 5.6% of those in general hospitals were missing. Sensitivity analyses have also demonstrated that our study resulted in fairly robust cost estimates.

The microcosting methodology is ideally combined with the bottom-up approach, in which cost components are valued by identifying resource use directly employed for a patient [16,22]. Nevertheless, our study applied the top-down approach in which cost components are valued by separating out the relevant costs from comprehensive sources (e.g., annual accounts). Additionally, lack of detailed data prevented us from assessing the costs of overheads and capital by means of more conventional methods, such as cost center allocation or inpatient day allocation [8,23]. Alternatively, marginal mark-up allocation was used for the cost estimation of overheads and capital. Previous studies concluded that the top-down approach may be a good proxy to the bottom-up approach and that marginal mark-up allocation may be sufficiently accurate for hospital services which are not expected to vary widely between patients [8,16,22,23]. This was the case in the present study, as the costs of medical imaging services, laboratory services, and medications were explicitly excluded. Costs of medical imaging services, laboratory services, and medications are considered to be highly dependent on the disease and treatment strategy and often explain total cost differences between alternative treatments. Therefore, we believe that the use of a top-down approach and marginal mark-up allocation did not markedly affect the results of the present study.

Inpatient hospital days, outpatient visits, and daycare treatments form important cost drivers in economic evaluations, but information on their unit costs is often lacking [7–9]. The present study provided unit costs for inpatient hospital days, outpatient visits, and daycare treatments in the fields of oncology and hematology. The results may be used as reference unit prices in economic evaluations assessing new expensive drugs for oncological and hamatological diseases in The Netherlands.

Acknowledgments

The authors would like to thank the employees of the clinical and financial departments of the participating hospitals who provided resource use and cost data for the cost calculations. The authors are grateful to Hedwig Blommestein, Anneke Spreij, and Eva de Vries for their contribution to this study.

Table 5 Regression models to explain total costs (hospital department n = 30)

Independent variable	Inpatient hospital days: Model 1a $R^2 = 0.766$ Coefficient	S.E.	Model 1b $R^2 = 0.732$ Coefficient	S.E.	Model 1c $R^2 = 0.718$ Coefficient	S.E.	Outpatient visits: Model 2a $R^2 = 0.728$ Coefficient	S.E.	Model 2b $R^2 = 0.539$ Coefficient	S.E.	Daycare treatments: Model 3a $R^2 = 0.679$ Coefficient	S.E.	Model 3b $R^2 = 0.643$ Coefficient	S.E.
Hospital characteristics														
Type of hospital	217.37	63.59***	254.40	30.73***	256.22	30.94***	49.84	22.03***	46.29	12.47***	79.00	55.13*	117.80	30.71***
Number of beds at the hospital	−0.03	0.12					0.05	0.05			−0.05	0.10		
Number of inpatient days	−0.03	0.43					−0.05	0.15			0.48	0.36*	0.29	0.17**
Inpatient hospital day characteristics														
Number of medical specialists	6.31	6.93												
Number of beds at the department	3.33	3.75												
Number of patients per day	−6.46	3.84*	−2.41	2.01										
Outpatient visit characteristics														
Number of medical specialists							−3.21	3.16						
Number of visits per day							0.23	0.89						
Mean duration of a visit							6.36	1.29***	4.00	1.03***				
Daycare treatment characteristics														
Number of medical specialists											5.18	6.40		
Number of beds at the daycare treatment											4.01	1.60***	3.78	1.52***
Number of patients per day											−5.78	1.65***	−4.61	1.25***

*$0.10 \le P < 0.20$; **$0.05 \le P < 0.10$; ***$P < 0.05$.
S.E., standard error.

Source of financial support: This study was supported by the Dutch Health Care Insurance Board (CVZ).

References

1 Groot MT, Huijgens PC, Uyl-de Groot CA. Introduction of expensive pharmaceuticals in haemato-oncology in the Netherlands and throughout Europe. Eur J Hosp Pharm Pract 2006;12: 30–6.
2 Rodenburg-van Dieten HEM. Richtlijnen voor farmaco-economisch onderzoek; evaluatie en actualisatie. Diemen: College voor zorgverzekeringen, 2005.
3 Uyl-de Groot CA, Giaccone G. Health economics: can we afford an unrestricted use of new biological agents in gastrointestinal oncology? Curr Opin Oncol 2005;17:392–6.
4 Dumarcet N. [Activity tarification and national guidelines for the proper use of expensive and innovative drugs in internal medicine]. Rev Med Interne 2008;29:84–6.
5 Jefford M, Savulescu J, Thomson J, et al. Medical paternalism and expensive unsubsidised drugs. BMJ 2005;331:1075–7.
6 Drummond M. Methods for the Economic Evaluation of Health Care Programmes. New York: Oxford University Press, 2005.
7 Oostenbrink JB, Buijs-Van der Woude T, van Agthoven M, et al. Unit costs of inpatient hospital days. Pharmacoeconomics 2003; 21:263–71.
8 Oostenbrink JB, Koopmanschap MA, Rutten FF. Standardisation of costs: the Dutch Manual for Costing in economic evaluations. Pharmacoeconomics 2002;20:443–54.
9 Adam T, Evans DB. Determinants of variation in the cost of inpatient stays versus outpatient visits in hospitals: a multi-country analysis. Soc Sci Med 2006;63:1700–10.
10 Hale JP, Cohen DR, Maughan TS, Stephens RJ. Costs and consequences of different chemotherapy regimens in metastatic colorectal cancer. Br J Cancer 2002;86:1684–90.
11 Hieke K, Kleeberg UR, Stauch M, Grothey A. Costs of treatment of colorectal cancer in different settings in Germany. Eur J Health Econ 2004;5:270–3.
12 Maroun J, Asche C, Romeyer F, et al. A cost comparison of oral tegafur plus uracil/folinic acid and parenteral fluorouracil for colorectal cancer in Canada. Pharmacoeconomics 2003;21:1039–51.
13 Ritzwoller DP, Goodman MJ, Maciosek MV, et al. Creating standard cost measures across integrated health care delivery systems. J Natl Cancer Inst Monogr 2005;35:80–7.
14 Coutet J, Limat S, Voillat L, et al. Economic impact of outpatient chemotherapy in multiple myeloma. Bull Cancer 2004;91:729–34.
15 Friedman BS, Wong HS, Steiner CA. Renewed growth in hospital inpatient cost since 1998: variation across metropolitan areas and leading clinical conditions. Am J Manag Care 2006;12:157–66.
16 Tan SS, Rutten FF, van Ineveld BM, et al. Comparing methodologies for the cost estimation of hospital services. Eur J Health Econ 2009;10:39–45.
17 Centraal Bureau voor de Statistiek. Statline. [cited Statline 2009]; Available from: http://statline.cbs.nl [Accessed January 1, 2009].
18 Koopman M, Antonini NF, Douma J, et al. Sequential versus combination chemotherapy with capecitabine, irinotecan, and oxaliplatin in advanced colorectal cancer (CAIRO): a phase III randomised controlled trial. Lancet 2007;370:135–42.
19 Lokhorst HM, van der Holt B, Zweegman S, et al. A randomized phase III study on the effect of thalidomide combined with adriamycin, dexamethasone (TAD), and high-dose melphalan, followed by thalidomide maintenance in patients with multiple myeloma. Blood 2010;115:1113–20.
20 van Agthoven M, Segeren CM, Buijt I, et al. A cost-utility analysis comparing intensive chemotherapy alone to intensive chemotherapy followed by myeloablative chemotherapy with autologous stem-cell rescue in newly diagnosed patients with stage II/III multiple myeloma; a prospective randomised phase III study. Eur J Cancer 2004;40:1159–69.

21 Ward SE, Kaltenthaler E, Cowan J, et al. The clinical and economic benefits of capecitabine and tegafur with uracil in metastatic colorectal cancer. Br J Cancer 2006;95:27–34.
22 Wordsworth S, Ludbrook A, Caskey F, Macleod A. Collecting unit cost data in multicentre studies. Creating comparable methods. Eur J Health Econ 2005;6:38–44.
23 Tan SS, van Ineveld BM, Redekop WK, Hakkaart-van Roijen L. Comparing methodologies for the allocation of overhead and capital costs to hospital services. Value Health 2008;12:530–5.