Pergamon

European Journal of Cancer, Vol. 35, No. 13, pp. 1789–1795, 1999

Printed in Great Britain
0959-8049/99/$ - see front matter

PII: S0959-8049(99)00216-6

Original Paper

The Costs of Managing Patients with Advanced Colorectal Cancer in 10 Different European Centres

N. Neymark and I. Adriaenssen

EORTC Health Economics Unit, Ave. E. Mounier 83, 1200 Brussels, Belgium

With the aim of estimating and comparing the direct hospital costs of managing patients with advanced colorectal cancer in various countries, data on resource utilisation and unit prices were collected. Data on the consumption of medical resources were collected by a retrospective examination of the hospital charts for 20 patients in each of 10 centres in five European countries. To make cost comparisons meaningful, a complete and consistent set of unit prices for all the medical resources used in each of the countries would be required, but this could not be achieved. As an alternative method of comparison, the most complete set of unit prices (from Belgium) was used here to estimate the imputed average total cost of patient management in each centre. By using this approach, a summary index was created, which reflected only differences in resource utilisation. This index showed that there were considerable differences in the amounts of resources used for treating these patients, between, as well as within, countries. Differences of the same order of magnitude were found, when the treatment of subgroups of patients, according to site and stage of disease, were examined. © **1999 Elsevier Science Ltd. All rights reserved.**

Key words: cost analysis, resource utilisation index, colorectal cancer
Eur J Cancer, Vol. 35, No. 13, pp. 1789–1795, 1999

INTRODUCTION

DETERMINING THE costs of treating and managing a particular group of patients may serve to establish a baseline, which may be helpful for future economic evaluations of specific new healthcare interventions aimed at these patients. Thus, the differences in the costs of the treatments compared in an economic evaluation may become easier to interpret, if there is information available about the average total costs of managing the patients concerned. It is also important to have knowledge about the extent of variability to expect in the costs per patient, partly for power and sample size considerations in planning new economic evaluations and partly for improving the analysis of the data.

Contrary to clinical outcome data, which are generally considered to be independent of the healthcare settings, cost data are highly dependent on the particular institutional and social context in which they are embedded. Cost data are composed of two parts, a quantity part indicating the types and amounts of resources used, and a price part giving the price per unit for each type of resource. Both absolute prices and the pattern of relative prices will normally vary between countries, so cost calculations must necessarily be situated in a specific social context at a particular point in time. As the purpose of economic evaluations of healthcare interventions is to determine the costs and outcomes of some treatment options and assess the relationship between costs and outcomes, they must also always be placed in a particular social and institutional context. This applies, of course, also to baseline assessments of patient management costs. It is worth noting that the transferability of the results of an economic evaluation to other settings than where the original cost data were derived, is a difficult question, which requires detailed and careful examinations on a case-by-case basis. This issue is currently receiving increasing attention [1, 2].

This paper reports the data of an attempt at determining the average total costs of managing patients with advanced colorectal cancer in five different European countries, Belgium, France, Germany, Italy and the U.K. Information on the medical resources used for managing these patients was collected by means of a retrospective examination of patient hospital charts. Types and quantities of resources used should be multiplied by the appropriate country-specific unit

Correspondence to N. Neymark, e-mail: nne@eortc.be
Received 20 Jan. 1999; accepted 26 Jul. 1999.

prices to determine the average total costs of patient management and an effort was therefore launched to identify pertinent unit prices in each country. This task was handed over to private consultancy firms in four of the countries, which primarily tried to obtain the relevant prices by requesting the necessary information from the accountancy departments of the hospitals involved. For Belgium, a consistent set of price data is readily available in public documents.

However, the search for unit price figures was decidedly unsuccessful in all four countries concerned. The difficulty of finding appropriate unit prices has to do with the financing mechanisms under which the hospitals operate. In each of the four countries, all the hospitals receive a yearly global budget, which is subsequently allocated to the various wards and departments, and which is to cover all activities throughout the year. Such a system provides few incentives to determine the actual costs of all the particular individual activities of the hospital's departments, which in itself is a difficult task, mainly because many costs are jointly incurred by several patients or activities. Relevant unit prices are accordingly very difficult to find, and it is hardly ever possible to determine the costs of treating a specific (type of) patient. Even after simplifying by regrouping resource items found in the patient charts into a smaller number of principal categories, it has in the present study not been possible to find more than approximately 50% of the necessary unit cost figures in the four countries. As a consequence, it has not been possible to attain the original aim of determining and comparing the costs of managing patients with advanced colorectal cancer in five different European countries.

However, for one country, Belgium, it has actually been possible to find a complete set of unit prices, which is consistent provided that a third party payer viewpoint is adopted for the analysis. The health insurance system in Belgium is based on retrospective reimbursement of the healthcare providers (for example, hospitals and the physicians working there) on a fee-for-service basis, and the corresponding list of fees (referred to as a Nomenclature) is very detailed and comprises more than 6000 different items. By using these reimbursement fees as unit prices, the costs of care from the viewpoint of health insurance may be determined. In addition to the health insurance reimbursement, there is a limited amount of patient co-payment for certain items, but this is ignored in the following. For a few of the resource use items observed in the patient charts, no corresponding reimbursement exists in the Nomenclature. These items have not been included in the analysis, but they concern no more than a few patients.

To allow a comparison as intended, we have used the Belgian set of unit prices for costing the observed resource use in Belgium and the four other countries. By this approach we create an index of the average total resource use per patient in each country. A simple direct comparison of the resource use patterns would become very complex and unwieldy, as there are too many variables to obtain a clear overview (even after extensive reduction of the number of variables, by grouping closely related resource use items, there remain more than a hundred resource use variables). By using a single set of unit prices as weights in the construction of a cost index, a simple summary measure is obtained, which allows comparisons between hospitals in different countries without the possible confounding due to differences in absolute price levels or relative prices. Actually, it is more accurate to consider the index as an index of resource utilisation, where the differences in the estimated values are due only to differences in the types and amounts of resources used for the management of the patients concerned and not to any price differences.

The analysis presented here is only descriptive, and there are far too few observations per centre to allow any claims about the statistical significance of the findings, just as an attempt at analysing the causes of the observed differences would be no more than speculative. However, the estimations are worth presenting in their own right, as they illustrate the usefulness of summarising resource utilisation data by means of an index and give a clear indication of the extent of variability to be expected between treatment centres and between patients.

PATIENTS AND METHODS

Preliminary summary results of the study in terms of aggregate quantities of resources used were presented by Torfs and Pocceschi [3]. Briefly, 10 centres (all members of the EORTC gastro-intestinal group) in the five countries mentioned were selected for participation in the study. In each hospital, 20 consecutive patients with a new diagnosis of stage III or stage IV colon or rectal cancer were selected, and data on medical care consumption from date of diagnosis to the date of either the patient's death or last known visit to the centre were retrospectively abstracted from the patient charts.

The resource use data comprise the number of hospital admissions (including admissions in other hospitals, if information was available); length of stay in various wards; visits to one day clinics; ambulatory visits; types of surgery; type, dosages and administration schedules of chemotherapy and radiotherapy; transfusions; diagnostic examinations and laboratory tests. There is no doubt that, as always with retrospective data collection, the data collected are not complete, so we cannot provide an accurate assessment of total cost. However, as the main purpose of the present study is to compare the 10 centres, and as we have no reason to suspect any systematic differences in the proportion of costs retrievable by examination of the patient charts, it seems reasonable to assume that the results are not biased by the incompleteness of the data.

The unit cost figures used for determining the indices derive from the Belgian health insurance system. The providers (hospitals) are reimbursed for every procedure performed or service provided. In addition to the intellectual activity of the physician, the reimbursement covers the materials and equipment used. Cytotoxics and other drugs used for chemotherapy are fully reimbursed. For each day of a patient's hospital stay, the hospital receives a *per diem* payment, which covers basic accommodation and nursing costs plus overheads for administration, etc. Similarly, fixed amounts are paid for other types of consultations and visits, e.g. for cancer patients receiving chemotherapy in a day clinic without being hospitalised. In addition, the hospital receives for each patient admitted a fixed fee that covers laboratory tests and another that covers radiological examinations.

The information included in the patient charts comprised altogether more than 1000 different resource items, a large proportion of which represented variations in the doses and schedules used for chemotherapy drugs. In the present analysis, the number of resource variables has been reduced by regrouping variables that are closely related, and all the variables covering chemotherapy have been collapsed into

one. The regrouping of variables has been done with clinical expertise provided by members of the EORTC gastro-intestinal group (particularly for the various forms of surgery) and taking into account the descriptions of the procedures covered by a particular code in the list of reimbursement fees.

The type of ward was registered for hospital stays, but the *per diem* payment is independent of the ward, so all hospital days are multiplied by 12 776 Belgian francs (BF). This is the per diem payment for 1998 for the hospital Gasthuisberg in Leuven, the largest university hospital in Belgium, where many colorectal cancer patients are treated. This amount corresponds approximately to the average *per diem* for university hospitals. Certain other fees are also dependent on the category of hospital, and for these we have used those pertaining to university hospitals. All variables covering hospital stays, consultations from other wards during admission, visits in day clinics, and provider (nurse) visits in the patient's home have been collapsed together in a single variable. These types of resource use may be considered potential substitutes, but we have chosen to collapse them here, because there were very few registrations of visits in the patients' homes, and in most centres day clinic stays have only been used for 1 or 2 patients. Between hospital days and outpatient visits, a negative correlation ($P = -0.44$) was found, which indicated a certain amount of substitution.

For surgery, the regrouping resulted in 45 variables to each of which a corresponding reimbursement fee could be found. These variables could be further classified into the categories: bowel surgery, stoma, catheter metastases and other procedures. For each of the 45 surgery variables, the number of procedures registered for the 20 patients from a centre has been multiplied by the pertinent fee to calculate the total costs per centre of this procedure. Subsequently, the costs for all 45 procedures have been summed by centre and divided by 20 in order to find the average total surgery costs for the centre concerned.

For chemotherapy, the actual doses registered for cytotoxics and modulators have been multiplied with pertinent unit prices and again summed for all patients and averaged. For tele-radiotherapy, the unit price used corresponds to the reimbursement fee for set-up, planning, dosimetry, etc. plus 20 fractions, which is the total of what is reimbursed in the Belgian system. For brachytherapy, the unit price covers the dosimetry in addition to the treatment itself. For the following types of treatments, autoimmunisation, selectron treatment, and hyperthermia, no corresponding code was found in the reimbursement list, and they have therefore been excluded from the calculation. Only 6 patients altogether have received either of these treatments, and in most cases only once. For transfusions, the unit price covers the transfusion of one unit of human blood plus the physician's fee for medical supervision.

The category 'diagnostic tests' comprises 37 variables, with the main categories electrocardiograms, barium enema procedures, X-rays, ultrasounds, computed tomography (CT) scans, endoscopies, scintigraphies and magnetic resonance imaging (MRI). The cost calculation follows the same approach as for surgery, and this has also been used for the category 'other treatments', which comprises 11 variables (the most frequent being lung function tests, electroencephalograms, and urodynamic tests). 'Laboratory tests' comprise many different tests, including tests for tumour markers and examinations of biopsies.

For each patient, total costs incurred are calculated by multiplying the observed quantity consumed of each resource item (altogether approximately 120 resource items) with the corresponding unit cost figures and summing. The unit cost figures used are available from the authors upon request.

The unit prices used are the reimbursement tariffs in force in 1998, and the amounts are reported in BF (Belgian Francs, 1 US$ = 36.8 BF, when PPPs (purchasing power parities) from the OECD are used for conversion).

RESULTS

Description of the patient sample

Table 1 contains summary data of the characteristics of the patients from eight of the centres. The principal source of resource use data for the patients from the two Belgian hospitals was the patients' invoices, which do not include such data on patient characteristics.

Across all the hospitals, the patients were almost equally divided among the four diagnostic categories distinguished here, but there were obvious differences in the case mix of the centres. Slightly more than half the patients were diagnosed with stage III colorectal cancer (53%), while the rest had stage IV disease at diagnosis. Of the patients diagnosed with stage III disease, 37% progressed to stage IV during the follow-up covered by the study. The median period of follow-up for the patients was 530 days, and for 84% and 67%, of the patients the 1-year and 2-year survival rates, respectively, could be assessed. For the patients with stage III disease initially, 1-year survival was 93% and 2-year survival 73%. For the patients diagnosed with stage IV disease, 1-year survival was 73%, and survival at 2 years was 27%.

Table 1. *Summary characteristics for the patients from eight of the hospitals*

Hospital	Mean age (years)	Male (%)	Average follow-up, months	Patients with the various diagnoses (%)			
				Colon III	Colon IV	Rectal III	Rectal IV
Italy 1	64	60	16	50	10	15	25
Italy 2	68	65	13	25	25	25	25
England 1	66	35	15	15	30	30	25
England 2	71	70	12	25	40	20	15
France 1	64	55	18	20	35	20	25
France 2	64	70	14	45	10	40	5
Germany 1	58	75	20	15	45	20	20
Germany 2	60	55	17	5	15	50	30
Total	64	60	16	23	27	28	22

*Table 2. Some moments of the distribution of total imputed cost per patient in the 10 hospitals, BF**

Hospital	Mean	Median	Minimum	Maximum	Coefficient of variation	Skewness
Italy 1	573 766	385 419	140 320	1 730 913	0.72	1.45
Italy 2	773 111	592 069	233 273	1 692 833	0.59	0.73
England 1	593 238	492 667	154 743	1 152 972	0.50	0.61
England 2	588 118	423 735	204 997	2 350 967	0.81	2.86
France 1	882 655	565 720	111 193	2 490 803	0.73	0.97
France 2	610 038	516 660	94 626	2 021 420	0.74	1.79
Belgium 1	797 713	662 027	139 956	1 855 172	0.60	0.82
Belgium 2	1 004 827	842 206	81 133	3 045 037	0.70	1.40
Germany 1	786 950	718 131	110 597	1 700 218	0.57	0.72
Germany 2	1 005 383	878 713	414 714	2 488 997	0.51	1.30

*Costs observed in all countries are found by applying Belgium unit prices to the resource uses observed.

Total imputed costs and their distribution

Table 2 presents the average total imputed cost per patient in each centre as determined by multiplying the average amount of resources used by a patient in this institution with the unit prices of the Belgian reimbursement system. The term imputed cost will be used interchangeably with resource utilisation in the following, for the sake of variation. In addition, some of the moments of the distribution of total imputed cost per patient are given for each centre. The average imputed cost per patient varied from approximately 570 000 BF to almost 1 million BF.

The characteristics of the distributions of total imputed cost show that these were not normal. For all hospitals, the mean of the imputed cost was higher than the median, indicating that all the distributions are right skewed. The more skewed to the right the distribution, the higher the measure of skewness. Within each hospital, there was a large spread between the patients with the highest and the lowest imputed cost, in most cases with the highest value being between 6 and 12 times the lowest. The most extreme difference was seen in the second Belgian hospital, where the cost of the most costly patient was 38 times higher than those of the least costly. Despite the very large ranges between the extreme values observed, the coefficients of variation varied only between 0.50 and 0.81, which is not indicative of excessive variability.

When combining Tables 1 and 2, there appeared to be a tendency towards a positive correlation between the average length of follow-up and the average resource use. The coefficient of correlation was 0.53, which, with only 6 degrees of freedom, is not statistically significant at the 5% level. When analysed at the individual patient level across all eight centres for which we have the necessary data, there was no relation between the period of follow-up and the imputed cost, as the coefficient of correlation was only 0.13.

Variations between hospitals

Table 3 summarises the index values for the average total resource utilisation as well as for the main cost factors into which the resource items have been grouped. For each index, the base has been chosen as 100 = the average across all centres, so the index values represent deviations from this average. The category 'other treatments' has been omitted, as most of these treatments have only been provided once or twice in a few of the centres. For resource items, where the index value would become zero due to rounding (despite some use of the resources for a few occasional patients), the index value has arbitrarily been set equal to 5.

It appears from the table that the differences between the hospitals were even more pronounced, when the principal resource use categories were examined individually compared with the average total resource utilisation alone. None of the hospitals had consistently the highest index values in all categories, just as none consistently had the lowest values. In any direct comparison between two centres, the differences thus tended to go in both directions, thereby diminishing the difference in total resource use. It is clear from the table that the differences between the two hospitals from any of the countries were as large as the differences between hospitals from different countries. The two French hospitals showed the largest intracountry difference in average total resource use of 35, while the two English hospitals were the most alike with the difference in average total resource use being 9.

A comparison of the hospital with the lowest value of average total resource use (Italy 1 (75)) with the two hospitals with the highest resource use (Belgium 2 and Germany 2

Table 3. Indices for the main resource categories

Resource items	Italy 1	Italy 2	England 1	England 2	France 1	France 2	Belgium 1	Belgium 2	Germany 1	Germany 2
Hospital stays, outpatient visits	67	110	78	80	116	73	117	144	80	136
Surgery	121	91	93	109	102	100	77	47	109	140
Chemotherapy	138	46	52	12	88	170	5	5	396	100
Radiotherapy	27	5	418	82	159	55	5	91	73	91
Blood transfusions	86	114	196	171	129	5	114	143	5	5
Diagnostic tests	92	121	53	47	139	82	87	158	84	132
Other examinations	50	67	58	50	75	50	275	250	67	83
Average total resource use	75	100	86	77	114	79	106	131	103	131

For each item, 100 = the average across all centres.

Table 4. Composition of average total resource utilisation when weighted with unit prices from the Belgian reimbursement system

Resource item (%)	Italy 1	Italy 2	England 1	England 2	France 1	France 2	Belgium 1	Belgium 2	Germany 1	Germany 2
Hospital stays, outpatient visits	70	85	71	81	78	72	86	86	61	81
Surgery	9	5	6	8	5	7	4	2	6	6
Chemotherapy	12	3	4	1	5	14	0	0	25	5
Radiotherapy	1	0	14	3	4	2	0	2	2	2
Blood transfusions	1	1	2	2	1	0	1	1	0	0
Diagnostic tests	6	6	3	3	6	5	4	6	4	5
Other examinations	1	1	1	1	1	1	4	3	1	1
Total*	100	101	101	99	100	101	99	100	99	100
Total amount, in BF	574 688	772 952	658 933	589 573	881 155	609 554	815 954	1 004 827	790 326	1 006 410

*Total does not always equal 100% due to rounding off of figures for the individual resource items.

(131)) revealed that the value for hospital stays, outpatient visits and other medical encounters in the Italian hospital was approximately 57% of the values observed in these latter two hospitals, while the values for surgery and chemotherapy were comparable with or greater than the values in the German hospital and much higher than those for the Belgian hospital. The other consistent difference was in the use of diagnostic tests, which was very much lower in the Italy, one hospital compared with the two hospitals with the highest resource use. As the unit price of a day in full hospital admission is high compared with the unit prices of most of the other resource items, differences in number of hospital days were highly determinative for differences in the weighted average resource use or average total imputed cost.

The high relative weight of hospital days was also clear from Table 4, which shows, for each of the 10 hospitals, the composition of the average total resource utilisation when weighted by the Belgian unit prices. Generally, hospital stays and other encounters with treatment and care providers account for more than three quarters of the imputed costs. As previously mentioned, hospital stays, outpatient visits and other types of encounters have been collapsed into one variable for this analysis. Outpatient visits are also a potential substitute for hospital stays, and when the average number of hospital days and outpatient visits were correlated, a negative non-negligible coefficient of correlation of -0.44 was found, but with only 8 degrees of freedom this was not statistically significant. However, in terms of resource utilisation weighted by a single set of unit prices, outpatient visits were completely dwarfed by hospital stays. As a proportion of the resources used for hospital stays, the resources for outpatient visits for the average patient amounted to no more than a few per cent, varying between 1 and 6%, with a modal value of 2%.

All the patients in the sample have been admitted to hospital at least once and have used the outpatient ambulatories and been given various diagnostic tests and other examinations, notably laboratory tests. For other resource items such as surgery, chemotherapy and radiotherapy, there were large variations between the centres in the proportion of patients given either of these treatments. Thus, between 10 and 20 patients per hospital had some kind of surgery, between 2 and 20 patients received chemotherapy, and from 1 to 11 patients had some radiotherapy.

The variations observed between the hospitals may be due to both differences in patient mix and hospital standard management protocols, and with the available data it was not possible to determine the relative importance of each of these factors. Although the total sample of patients was almost evenly distributed among the four categories of patients distinguished here, Table 1 shows that there were marked differences in the case mix of the eight hospitals for which these data were available. As the recommended treatment options, and by implication the total use of resources, for the four types of patients differed considerably, case mix would be expected to be an important explanatory factor to examine.

To this end, Table 5 reports index values for average total resource use per patient category in each of the eight hospitals for which we have data. Again, for each patient category, the index values were determined relative to the average across all

*Table 5. Indices for average total resource utilisation per centre for each category of patients**

Hospital	Colon III	Colon IV	Rectal III	Rectal IV	Overall index
Italy 1	81	104	71	103	75
Italy 2	144	94	103	96	100
England 1	106	50	95	79	86
England 2	115	90	64	74	77
France 1	132	135	96	123	114
France 2	64	151	88	42	79
Germany 1	109	107	81	127	103
Germany 2	149	94	144	104	131
Overall average amount, in BF	549 833	752 221	881 778	716 564	770 437

*Index = 100 for the average value across all the hospitals for each patient category. It must be noted that the subdivision into four patient subcategories implies that some of the estimates are very unstable, as they are based on very few observations. In particular, the French hospital 2 included only 2 and 1 patient(s), respectively, in the categories, where the most extreme values were found. But, similar although less marked, divergencies were found for the other hospitals.

the hospitals. It appears, from the aggregate average imputed costs expressed in BF in Table 5, that average total resource use was lowest for patients with stage III colon cancer, while it was highest for patients with stage III rectal cancer. The difference between these was 60%, while stage IV colon and rectal cancer were both approximately midway between these two extremes. However, these relations between average total resource use for the various patient types at the aggregate level were not found in any of the individual hospitals (data not shown), in which the relation between the amounts of resources used for the various types of patients was highly variable.

Table 5 shows that there were no consistent patterns between the individual hospitals' use of resources for the four patient categories. Hospitals that use many resources (compared with the average) for one type of patients may use much less than the average on other types, the extreme example of this being the second French hospital (France 2). The two extreme hospitals, in terms of average total resource use for all patients combined, both diverge the most from an even distribution of patients across disease categories, but the amounts of resources they used for the patient types concerned were also very different from the average across all hospitals. Thus, in the first Italian centre with an overall index of 75, 50% of the patients had stage III colon cancer, and the institution used only 81% of the average amount of resources for this patient category. Conversely, the second German hospital with an overall index value of 131, where 50% of the patients had stage III rectal cancer, used 44% more resources than the average on this type of patient.

DISCUSSION

Empirical cost distributions are rarely presented, but one other example for patients with colorectal cancer can be found in ref. [4], based on data from the American SEER-Medicare database [5, 6]. In the American cost data, all the distributions (depending on the stage of disease) have a measure of skewness higher than 4 and maximum costs more than 20 times the mean. The degree of variability is also higher than in the data presented here, with coefficients of variation ranging from 0.8 to 1.46.

Calculating resource use indices by multiplying quantities of resources used with a single set of unit prices offers a unique opportunity to compare real costs in different hospitals in various countries. By avoiding the confounding with differences in absolute prices, such a comparison reflects cost differences that are due to real differences in the quantities of resources used per patient. A precondition for the validity of such a comparison is, of course, that resource items with identical nominal designations are sufficiently equivalent among hospitals in various countries to make it sensible to treat them as identical.

Our study showed that the differences between the hospitals observed at the aggregate level could not be explained solely by variations in the case mix, even though this factor clearly also played a major role. But within the four patient types distinguished here, the interhospital differences in resource use were just as wide, if not wider, than at the aggregate level. For all the hospitals, their deviation from the average went in both directions, even though for some the tendency seemed to be more consistently in one direction.

Many different factors may explain these differences in resource use, but the available data do not allow a determination of their relative importance or relevance. Neither do we possess sufficient outcome data to attempt to analyse the possible relations between resource utilisation and patient outcomes in terms of survival, not to mention more relevant outcome measures like quality adjusted survival, where the impact of the disease and the treatment on the patients' quality of life are taken into account. Normally, it would be expected that using more resources per episode of treatment would improve the outcome, but, at the same time prolonged survival may in itself be expected to lead to a higher level of resource use no matter what the rate of use per treatment episode.

Even within more narrow diagnostic groups there may be huge differences between individual patients and their need for medical procedures, *inter alia* because of variations in comorbidities. Focusing on individual categories of patients, there may still be systematic differences between the patients treated by the hospitals, e.g. if some hospitals are referral centres that receive the more difficult cases from less specialised hospitals.

Another possible explanatory factor is differences in the relative prices, which may lead providers in different countries to select different combinations of medical services and procedures even if managing identical patients. Thus, they use 'diverging production functions'. But, normally the relative prices will be more or less the same for all institutions within individual countries, so this factor should be of most importance in explaining intercountry differences. The considerable divergences observed between the two hospitals from each country (Table 5) must primarily be explained by other factors.

Some of the other potential explanatory factors may be variations in the availability of particular services and, more or less independent of this, variations in local protocols for the handling of these patient types. In the absence of a clear consensus about the most appropriate approach to patient management, there are wide possibilities for variations in small details of patient management, even in cases where there is general agreement about the most appropriate treatment modalities and schedules. Cumulatively, such differences in details, e.g. how many days patients are kept in hospital before and after normal surgery with an expected outcome, may have a decisive impact on aggregate resource utilisation.

Comparing the performance of different hospitals is the most useful approach to analyse questions of hospital efficiency, i.e. the relation between inputs (medical resources), outputs (services provided, procedures performed), and outcome (effect on patients' health or quality adjusted survival). The most commonly used techniques (such as Data Envelopment Analysis or DEA) result in relative efficiency measures, with the largest possible efficiency being determined among the hospitals examined. That the method only allows assessment of relative efficiencies should not be seen as a major problem, as it is very difficult to define an external standard for hospital efficiency.

With data resembling those used for the present study, Bosmans and Fecher [7] have demonstrated an interesting alternative approach to stochastic frontier analysis for the measurement and comparison of hospitals' performances. The notion of efficiency used in this approach is defined as the ability of a hospital to minimise the medical fees incurred in the treatment of a patient's disease. The notion is based on

an idea of a function of resources, a relationship between medical fees and the patient's pathology. Out of this function is constructed a best practice reference frontier, which defines the minimal hospital resources needed to treat the pathology. The level of inefficiency is determined by that frontier, i.e. a hospital is defined as inefficient, if the medical fees involved by the treatment of a patient's pathology are above the frontier. With only 20 observations per hospital, we are unfortunately not able to analyse the data using this approach.

With differences in resource uses as large as those described in this study, it seems inescapable that there are in some centres deficiencies in efficiency in the sense of the concept used by Bosmans and Fecher [7]. The impact of the potential explanatory factors mentioned and probably others as well would be difficult to establish as they are likely to interact in complex ways. However, differences in resource use of the magnitude observed imply that the possible pay-off to an in-depth examination might well make it worthwhile to try to identify ways of improving efficiency in the least efficient centres.

CONCLUSION

Comparisons between various providers of similar services to more or less homogeneous types of patients have attracted increased interest in healthcare service research in recent years. Such comparisons will frequently be the only or the most appropriate means of assessing the performance of individual providers, and they are often used for the purpose of benchmarking.

Cross-country cost comparisons are also considered useful, but if they take the form of comparing the costs of managing various types of patients over their course of disease, there is an obvious danger that intercountry differences in absolute and relative prices may confound the results. A simple way to avoid such confounding is to use a single country's set of unit prices for the calculation of imputed costs for each of the countries concerned. In essence, this procedure amounts to constructing an index of aggregate resource utilisation for each country, with the common weights of the index corresponding to the single set of unit prices.

This study has demonstrated the use of this approach to compare the management of patients with advanced colorectal cancer by hospitals in five European countries. Even when subdividing the patients into four more narrowly defined diagnostic groups there remained considerable differences between the hospitals in the average amount of resources used for managing these patients.

1. Hutton G. Can the costs of antenatal care (ANC) be generalised across countries? Abstract book of the 2. iHEA World Conference on Health Economics, 1999, 95–96.
2. Grieve R. Can we generalise from costs measured in one country to another? Abstract book of the 2. iHEA World Conference on Health Economics, 1999, 79.
3. Torfs K, Pocceschi S. A retrospective study of resource utilization in the treatment of advanced colorectal cancer in Europe. *Eur J Cancer* 1996, **32A**(Suppl. 5), S28–S31.
4. Brown M, McCabe M, Schulman K. Integrating economic analysis into cancer clinical trials: the National Cancer Institute—American Society of Clinical Oncology economics workbook. *J Natl Cancer Inst Monograph* 1998, (24).
5. Potosky A, Riley G. SEER-Medicare database linking project; analysis plan and project results. Report to NCI. Applied Research Branch, NCI, Bethesda, 1992.
6. Potosky A, Riley G, Lubitz J, *et al*. Potential for cancer related health services register using a linked medicare-tumor registry database. *Med Care* 1993, **31**, 732–748.
7. Bosmans N, Fecher F. Performance of Belgian hospitals: a frontier approach. *Health Econ* 1995, **4**, 389–397.

Acknowledgements—The EORTC Health Economics Unit received funding for this study from Zeneca. The following clinicians participated in this study: Drs H. Wilke, Essen, H. Köhne, Berlin, Germany; B. Nordlinger, P. Rougier, Paris, France; D. Civalleri, Genova, D. Nitti, Padova, Italy; D. Kerr, Birmingham, G. Poston, Liverpool, U.K.; H. Bleiberg, Brussels, Belguim; J. Degreve, Brussels, Belguim. The very perceptive and helpful comments of two anonymous referees have greatly helped to improve the final version of this paper.