

Costs of Radiotherapy

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A systematic assessment of radiotherapy for cancer was conducted by The Swedish Council on Technology Assessment in Health Care (SBU) in 2001. The assessment included an overview of the capacity for radiotherapy in terms of infrastructure of cancer care and an estimation of the costs of radiotherapy in Sweden. A postal questionnaire distributed to all 16 centres of radiotherapy in Sweden showed the following results:

- In 2000 there were 57 accelerators with complementary equipment in operation, 24 of which had been installed 10 or more years ago earlier.
- The total cost of external radiation therapy was estimated at SEK 427 million in the year 2000, or approximately 5% of the estimated total cost of oncology care in Sweden. The total cost of brachytherapy was estimated at SEK 43 million or about one-tenth of that of external radiotherapy.
- The total cost of external radiotherapy has increased since the last inquiry (1991) by about 16% more than the general inflation in Sweden, but at the same time the volume of fractions has increased by about 37%. Thus, an increase in the efficiency of external radiotherapy, calculated per fraction, was achieved in the 1990s.
- At the department level, there was a clear correlation between cost of salaries and output of fractions of external radiotherapy, thus indicating the adaptation of manpower to the volume of patients. There was an even higher correlation between the number of accelerators and the volume of fractions of radiotherapy, which suggests the occurrence of certain economies of scale in Swedish external radiotherapy.

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CAPACITY FOR EXTERNAL RADIOTHERAPY AND BRACHYTHERAPY IN SWEDEN

A questionnaire was sent to all 16 units of radiotherapy in Sweden (November 2001). The inquiry concerned the year 2000, looking at four major aspects of radiotherapy: employees and competence, equipment, building area and statistics on the production volume.

Staffing

Employees according to the questionnaire to the departments of external radiotherapy are presented in Table 1.

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Owing to differences in definitions and in administrative systems at the departmental level, the answers to the inquiry may contain some incomplete results, but where it has been possible to carry out verifications, the included data agreed well with information from other sources.

Equipment

According to the inquiry, the 16 departments of radiotherapy had 57 accelerators in operation, of which 6 were installed during the past year. More than 40% of the accelerators (n = 24) were installed 10 years ago or earlier (Fig. 1).

Total investments in external radiotherapy, according to the inquiry, were SEK 497.5 million. Other equipment was installed at an original investment value of SEK 158.7 million for external radiotherapy. Systems for verification were included by only a few clinics, but calculated for all clinics, they would make a total investment of about SEK 100 million. Thus, the total investment in equipment, including about SEK 53 million for brachytherapy, corresponded to about SEK 800 million. The annual cost of the

Table 1

Employees expressed as full-time employment equivalents in the year 2000, according to questionnaire responses

	Total	External radiation	Brachytherapy
Physicians	55.6	43.7*	11.9
Physicists	59.8	52	7.8
Medical technicians	9.1	8.5	0.6
Engineers	36.4	33.5	2.9
Nurses	340.8	321.2	19.6
Assistant nurses	15	7	8
Head nurses	20.7	19.2	1.5
Other categories	35.1	30.6	4.5

* Of which 34 were employed on 75% basis or more.

total investment, however, corresponds to a much smaller sum (roughly one-tenth of the investment, see Table 5). Details regarding equipment are included in Table 2.

Building area

According to the questionnaire responses, the following building area was available, excluding corridors and staircases (Table 3).

The three kinds of building area were of approximately the same total size for external radiotherapy as expressed in square metres. Brachytherapy had about one-tenth of the area available for external radiotherapy.

Statistics on production of radiotherapy

Statistical data on production in 2000 according to the answers to the questionnaire are shown in Table 4. The corresponding figures for 1991 are stated in parentheses.

During the 1990s there was an increase in external radiotherapy by 37% in terms of fractions, by 41% in terms of patients and by 55% in terms of fields.

In the same period the number of fractions per accelerator increased by about 20%.

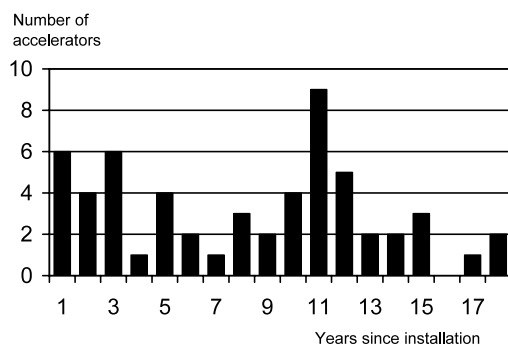


Fig. 1. Number of accelerators by time since installation.

CALCULATION OF COSTS OF EXTERNAL RADIOTHERAPY AND OF BRACHYTHERAPY

Calculation based on changes in the healthcare cost index

According to the previous report on radiotherapy (1), the total cost of radiotherapy in Sweden was estimated at SEK 259 million for 1991, based on the balance sheet for that year. An estimate for the year 2000, by an increase of costs corresponding to the healthcare cost index (HCCI) for Sweden for the period 1991–2000, i.e. +37.3%, would give an estimated total cost of SEK 356 million (the department in Växjö opened at the end of 2000 and was therefore not included).

Calculation of costs based on the inquiry

Another way to calculate the total cost is to use the data from the questionnaire combined with data from the previous report and upward adjustments based on the consumer price index for building costs and certain other costs:

- Salary costs including social overhead costs, etc., based on questionnaire data on the number of employees of different categories and average salaries for different categories of employees for the year 2000.
- Depreciation costs of equipment, based on questionnaire responses about purchase costs and 12 years of economic life and a 5% capital cost (12 years is chosen in order to make a comparison with the earlier report possible).
- Total cost of capital of buildings, based on building area according to the questionnaire and the stated cost of buildings per square metre in the previous report on radiotherapy, upgraded by the consumer price index (CPI, i.e. +14.7%) (2).
- Cost of services and overheads (department and hospital) according to the previous report, upgraded by the HCCI index for the period 1991–2000. For medical services the volume is adjusted upwards to correspond to the increase in the number of patients.

This calculation gives the totals and estimated costs per field as listed in Table 5.

There was an increase in the volume of fields from 1991 to 2000, from 518 994 to 805 362, i.e. an increase in fields of about 55%. The estimated cost per field in the year 2000 was about SEK 530. This is comparable with the cost per field for 1991, i.e. SEK 499, which after adjustment in accordance with the HCCI would correspond to roughly SEK 685 at year 2000 price levels. Calculated as the cost per field and expressed in real costs, there was thus an increase of efficiency in the 1990s, which can probably be ascribed in part to a gradual increase in the automation and computerization of external radiotherapy in Sweden. The esti-

Table 2
Equipment for radiotherapy and brachytherapy

Clinics	Accelerators	Check & confirm equipment	MLC	EPID	Simulators	CT	Brachy
Borås	2	VS III			1	1	
Eskilstuna	2	Vericord	1		1		
Gävle-Sandviken	3	Varis	2		1	1	
Göteborg	6	Varis	6	4	1	2	1 HDR, 1 PDR, 2 MDR
Jönköping	1*	Visir	1	1	1		
Karlstad	2	Varis	2	2	1		
Linköping	4	Varis	4	2	1		1 HDR
Lund	7	Visir	3	1	2	1	1 LDR, 1 HDR, 1 PDR
Malmö	3	Visir	3	2	1		
Örebro	3	Varis	3	3	1	1	1 HDR
Stockholm, Huddinge	3	Varis, Lantis	3	1	1	1	
Stockholm, Karolinska	8	Visir	5	1	2	1	2 LDR, 2 HDR
Umeå	5	Visir	2	2	1	1	2 LDR
Uppsala	4	Theraview	3	2	1	**	1 LDR, 1 HDR
Västerås	2	Varis	2	2	1		
Växjö	2	Varis	2	2		1	

* Plus one accelerator being replaced.

** Included in simulator.

Abbreviations: MLC = multileaf collimator; EPID = electric portal imaging device; LDR/HDR = low/high dose rate.

mated average cost per fraction, with an average of 2.6 fields per fraction according to the results of the questionnaire corresponded to about SEK 1 378 (i.e. 2.6×530).

COST STRUCTURE

Calculations of the cost structure for radiotherapy were based on data from the questionnaire concerning resources and in accordance with the factors stated above. The Swedish salary costs, capital costs, and other costs are compared in Table 6 with corresponding data from three foreign studies (3–5). The share of salary costs is calculated

Table 3

Building area for external radiotherapy and brachytherapy, 2000

	Radiotherapy	Brachytherapy
Radiation-protected area	5 699m ²	653m ²
Special areas (laboratories, etc.)	5 200	452
Other areas (offices, etc.)	5 608	261

Table 4

Production of external radiotherapy and brachytherapy, 2000 (1991)

	Radiotherapy	Brachytherapy
Patients	17 915 (12 700)	1 241
Fields*	805 362 (518 994)	
Fractions*	310 482 (225 700)	2 354

* Missing data on 2 clinics are replaced by the mean value obtained for the other 14 clinics, i.e. approximately 2.6 fields for each fraction.

as slightly more than half of the total costs, while capital costs account for just over a fifth. Although salary costs constitute a smaller proportion in Sweden than in other countries, there were considerable similarities in the composition of the cost structures.

The total direct costs of cancer care, that is, medical care, drugs, and municipal nursing homes, were estimated at about SEK 7 300 million for the year 2000 (pers. comm., Lars-Åke Marké, SBU). The estimated total costs of

Table 5

Radiotherapy. Total cost, cost structure (%) and cost per field, 2000

Cost	SEK million	Percentage	Cost per field
Salaries	217.7	51.0	270.35
Other direct costs	46.3	10.8	57.45
Capital, equipment	85.3	20.0	105.90
Capital, buildings	26.4	6.2	32.75
Other costs*	51.5	12	64.00
Total	427.2	100	530.45

* Costs of medical and other services, plus overheads.

Table 6

Comparison of cost structures for radiotherapy

Author	Smith (3)	Daly-Schweitzer (4)	Duncombe (5)	This study
Year	1995	1995	1999	2000
Country	Australia	France	Great Britain	Sweden
Salaries, %	55	62	56	51
Capital, %	29	19	19	26
Other, %	16	19	25	23

external radiotherapy (SEK 427 million) thus corresponded to about 5.6% of the total healthcare cost for cancer, i.e. more or less the same percentage as estimated for 1991 (1). When SBU in 1996 evaluated the role of chemotherapy in cancer, the estimated total costs of chemotherapy, SEK 800 million, corresponded to about 12% of the total cost for cancer (6).

Economies of scale

The utilization of equipment is important for the potential to achieve economies of scale. In the previous report on radiotherapy the preconditions for economies of scale in external radiotherapy were discussed.

The questionnaire responses about equipment show the total capacity available in the form of accelerators and the extent of utilization in terms of the number of fractions produced. A simple regression analysis showed a (adjusted) correlation of 93%, i.e. a high correlation between equipment capacity and degree of utilization. There is no tendency towards any 'staircase' in the plot of the model that might indicate any threshold effects in external radiotherapy (Fig. 2).

Another way to analyse capacity utilization is to compare the output of fractions with salary costs. A (adjusted) linear regression analysis gives a figure of 0.92, thus indicating a high correlation between input of manpower and output of fractions in the Swedish departments of radiotherapy.

This analysis in the form of correlation of resources and output fractions is greatly simplified in that no correction has been made for differences in the composition of patients or diagnoses.

Costs of brachytherapy

Based on the results of the questionnaire, a calculation of costs was made for brachytherapy in the same way as for external radiotherapy. The numbers of employees are presented in Table 1 and the past investment in equipment

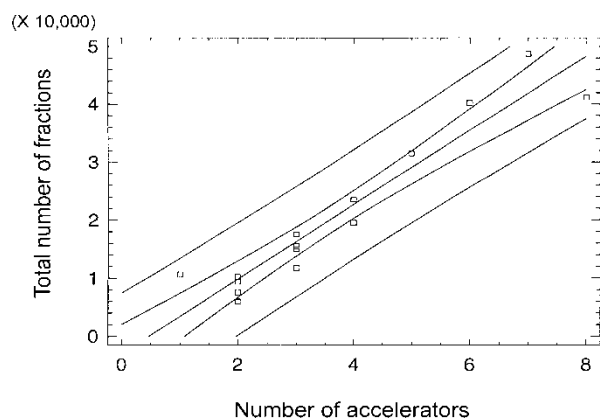


Fig. 2. Relation between number of accelerators and number of fractions at specific departments. Number of fractions as a function of the number of accelerators.

was about SEK 53 million. Building areas in use for brachytherapy amounted to 653m² for radiation-protected areas, 452m² for special areas, and 261m² for other areas. Other direct costs, i.e. medical and other services and administration costs were estimated to be in the same proportion as those for external radiotherapy. Thus, the calculated total costs would correspond to those listed in Table 7.

In the previous report on radiotherapy the total cost of brachytherapy was estimated at SEK 36 million for 1991, based on accounting data. Corrected only for inflation in the period 1991–2000, the total costs for 1991 would correspond to about SEK 41 million in the year 2000 (2). Thus, if these calculations based on the questionnaire data are reasonable, the real cost of brachytherapy remained almost constant over time. Based solely on the number of fractions and treated patients, the average costs of brachytherapy in the year 2000 corresponded to about SEK 17 500 per treated patient.

Calculation of costs for different diagnoses, and of low-dose versus high-dose treatment, would require more specified data than those elicited by the questionnaire. The choice between low dose rate and high dose rate brachytherapy, according to a published study (7) seems to depend mainly on the volume of patients.

COST OF TREATMENT OF PROSTATE CANCER—AN EXAMPLE FROM A SWEDISH COUNTY COUNCIL

It was shown in a report from the county council of the Region Skåne, southern Sweden, that in the year 1998 roughly half of the healthcare budget of the county council was utilized for just over 40 000 patients or about 3.5% of the population (8). Of these patients, around 4 500 had cancer, and the average cost per cancer patient was about SEK 132 000, drugs not included. Since mortality is relatively high for cancer patients compared with the average for all patients, and since it is well documented that treatment measures in the last years of life are particularly costly (1% of the population dies every year, claiming about 10% of the county council's total budget), the resources expended in the last year of life may have affected the average costs per cancer patient. However, not all patients with cancer incur such high costs: for instance, patients with prostate cancer. After the initial care with treatment (e.g. surgery) and subsequent radiotherapy,

Table 7

Calculated total cost of brachytherapy in Sweden, 2000

Employees	SEK 25.5 million
Capital, equipment	6.0
Capital, buildings	2.7
Other costs	8.6
Total estimated costs	SEK 42.8 million

Table 8*Incidence (and prevalence) of prostate cancer, per 1 000 male inhabitants*

Age-group	1998	1999	2000
–64	0.4 (1.4)	0.5 (1.3)	0.6 (1.2)
65–74	7.2 (23.9)	8.7 (24.2)	9.2 (23.8)
75–	9.0 (25.1)	10.6 (28.1)	10.4 (28.9)
All men	1.6 (4.9)	1.8 (5.1)	2.0 (5.0)

Table 9*Prostate cancer (first diagnosis), average utilisation of resources, and average health care cost (drugs not included) for the year 2000*

	Outpatient care only	Inpatient and outpatient care
Number of patients	1 161	2 762
Physician visits	5.9	8.3
Other visits	5.3	6.3
Surgery	0.3	0.8
Inpatient days	–	5.0
Healthcare cost, SEK	10 289	40 953

prostate cancer patients mainly require outpatient care and drugs. Based on data from the Regional Tumour Register for Southern Sweden and the patient administration system for the county council of Region Skåne, it has been possible to calculate needs and resource utilization (Tables 8 and 9).

Based on these data on the prevalence of prostate cancer, it was possible to calculate resource utilization and costs (Table 9).

The costs of radiotherapy alone for patients with prostate cancer, at 38 fractions per patient (according to the guidelines (9)) are estimated at about SEK 52 400 (i.e. $38 \times 1\,378$), a sum that exceeds the total average. The explanation for the difference is that only a small number of all patients with prostate cancer (prevalence) receive radiotherapy within the same year.

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