

# Radiotherapy Practices in Sweden Compared to the Scientific Evidence

Christer Lindholm, Eva Cavallin-Ståhl, Jeanette Ceberg, Jan-Erik Frödin, Bo Littbrand, Torgil R. Möller for the SBU Survey Group\*

From the Department of Oncology, Ryhov Hospital, Jönköping (C. Lindholm), Department of Oncology, Lund University Hospital, Lund (E. Cavallin-Ståhl), Oncological Centre, Lund University Hospital, Lund (J. Ceberg, T.R. Möller), Radiumhemmet, Karolinska Hospital, Stockholm (J.-E. Frödin) and the Department of Oncology, University Hospital, Umeå (B. Littbrand), Sweden

Correspondence to: Torgil R. Möller, Oncological Centre, Lund University Hospital, SE-221 85 Lund, Sweden. Tel: +46 46 177 550. Fax: +46 46 188 143. E-mail: [torgil.moller@telia.com](mailto:torgil.moller@telia.com)

Acta Oncologica Vol. 42, No. 5/6, pp. 416–429, 2003

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 a critical review of the literature on radiotherapy for cancer published in 1994–2001 and a prospective survey of radiotherapy practice in Sweden during 12 weeks in the autumn of 2001. The results of the survey were compared with the evidence derived from the scientific literature, and the following conclusions could be drawn:

- Radiotherapy is currently given to approximately 47% of new cancer cases. This figure is on a par with rates reported from other countries.
- For most tumour types, curative radiotherapy practices in Sweden are generally supported by the literature.
- Interstitial brachytherapy has been included in the treatment of non-gynaecological malignancies, and prostate cancer is now the most common indication.
- Palliative radiotherapy has increased and is today given in a more rational way using single or few fractions. However, it still seems to be under-utilized in Sweden.
- The need for radiotherapy can be expected to increase until the year 2010.

Received 20 March 2003

Accepted 13 April 2003

Systematic assessments of treatment effects are important methods to optimize health care. The Swedish Council on Technology Assessment in Health Care (SBU) has assessed radiotherapy and chemotherapy for cancer and compared the evidence derived from the scientific literature with the results of prospective surveys of therapy practice in Sweden. A first report on radiotherapy practice was published in 1996 (1), where the scientific evidence from the literature before 1994 was compared with the clinical practice at that time. The results of the chemotherapy comparison were published recently (2). This report is an update of the

previous radiotherapy report and discusses radiotherapy practices in Sweden in 2001 compared to the literature-based evidence from 1994 and onwards. It also highlights changes in radiotherapy practice that have occurred between the two assessments.

## MATERIAL AND METHODS

### *Literature reviews*

*Previous review—SBU 1996.* A review of the scientific literature on radiotherapy for cancer was undertaken in 1993 in order to assess the role of radiotherapy for those tumour diagnoses that make the biggest quantitative demands on radiotherapy, and to evaluate the practices of radiotherapy in Sweden (3). The literature review addressed 12 tumour groups that together utilized 89% of all radiotherapy in Sweden. The review encompassed 1 666 articles, out of which 655 were considered to have a high scientific

\* Other members of the SBU Survey Group: Bengt Brorsson, SBU, Stockholm; Nina Einhorn<sup>†</sup>, Radiumhemmet, Karolinska Hospital, Stockholm; Gunilla Lamnevik, SBU, Stockholm; Anders Norlund, SBU, Stockholm; Urban Nylén, Radiumhemmet, Karolinska Hospital, Stockholm; Hans Svensson, Departments of Medical Radiation Physics, Umeå University, Umeå and the Karolinska Institute, Stockholm.

<sup>†</sup>Deceased 2002.

value. The number of patients included in these studies was 709 788 and 551 900, respectively.

The conclusions drawn from this review are briefly summarized for each tumour type.

*Present literature update.* A new literature review was carried out during the year 2001. This update covers literature published from 1994 to 2001, but was concentrated primarily on randomized studies. The same tumour types as in the previous report were studied, with the addition of oesophageal cancer and bladder cancer. Brain metastases were not reviewed. The conclusions of this literature update are based on 934 articles, of which 448 were considered to have a high scientific value. The total number of patients included in these articles was 338 608 and 268 170, respectively. The conclusions of this literature update, by tumour type, are also summarized in this paper.

It should be pointed out that the literature concerning other treatment methods without radiotherapy has not been examined. The literature concerning chemotherapy for cancer was recently reviewed by the SBU (4).

#### *Surveys of practice*

*Previous survey of 1992.* The previous study also included a survey of radiotherapy practice in Sweden, conducted during a 12-week period in the autumn of 1992 (1). All 15 departments of general oncology and 7 departments of gynaecologic oncology participated in this inventory. The survey comprehensively registered several items of data concerning radiotherapy patients with specific diagnoses. These diagnostic groups included in the survey corresponded to approximately 60% of all newly diagnosed cancer patients in Sweden. The diagnoses were chosen based on the need for radiotherapy, and included 82% of patients receiving radiotherapy in Sweden. The survey included nearly 3000 patients, utilizing 48 839 fractions and 114 370 fields.

*Present survey of 2001.* A new survey of radiotherapy practice in Sweden was carried out during the same 12-week period in the autumn of 2001 (5). In contrast to the previous survey, data on all patients who started radiotherapy during the study period, regardless of diagnosis, were collected. A total of about 5500 treatments were given to 4500 patients.

The number of treatments with radiotherapy in the surveys is related to the number of incident cases for the years 1992 and 2000, respectively. In the period 1992–2000, the total number of incident cases increased by 10.5%.

The following sections discuss radiotherapy practices in Sweden in 2001 compared to the practices supported by the current literature. Only those tumour types that were covered by the literature reviews are included. For a detailed listing of dose-fractionation patterns employed in specific situations, the reader is referred to Table 10 in (5).

## RESULTS

### *All sites combined*

It was estimated in the 1992 survey that about 13 000 treatments were given annually in Sweden, meaning that approximately 32% of all tumour patients received radiotherapy at some stage during their disease. A corresponding estimate based on the 2001 survey shows a noticeable increase, with over 21 000 treatments given that year. The treatments were given to an estimated 47% of newly diagnosed cancer cases, which would mean that between 14 000 and 17 500 patients annually receive radiotherapy in some phase of their disease.

*Literature review.* Figures from the USA show that 50–60% of all cancer patients are given radiotherapy (6), half of the cases with curative intent. Reports from the European Union (EU) (7–9) state that two out of three cancer patients receive radiotherapy, with one-third of the cases intended as curative treatment and the remaining two-thirds as palliative treatment. It is difficult, however, to compare these figures with those obtained by the Swedish surveys. Few studies are based on data collected about individual patients, as this report is (10–13). It is more common to make various types of estimates, which is of course a more uncertain basis (6–9, 14–16).

A study from 1989 to 1990 compared the use of radiotherapy in the USA and Japan, finding very large differences. In the USA, which is estimated to have 9.6 treatment machines per million inhabitants, radiotherapy was given to 49% of tumour patients. The figure varied for different regions, between 42% and 52%. Japan was estimated to have 4.0 machines per million inhabitants, but there only 15% of tumour patients received radiotherapy. Japan likewise showed regional variation, with figures between 6% and 25% (14). A compilation from six provinces in northern Germany with a population of 17.36 million shows that 32 000 patients were treated in 1995 (13), which agrees fairly well with the Swedish figures. From New South Wales in Australia it is reported that the proportion of newly diagnosed cancer patients receiving radiotherapy increased from 30% in 1990–1991 to 37% in 1998 (15). In Ontario, Canada, the proportion given radiotherapy is described as having increased from 39% in 1984 to 42% in 1995 (16). Another study from Ontario analysed the proportion of patients with breast cancer who received radiotherapy within one year of the date of diagnosis. It was found to have increased from 21% in 1982 to 45% in 1991. Lower age, higher socioeconomic status, and short distance to the radiotherapy clinic increased the probability of receiving radiotherapy (12).

According to the 1992 survey, 50% of patients were given radiotherapy with curative intent. These patients utilized 68% of the radiation fractions and 72% of the fields.

In 2001 the proportion of curative treatments had increased slightly, to 54%, with a great difference between different clinics. Seventy-eight percent of the radiation fractions and 85% of the fields were given with curative intent.

The Canadian report (16) also analysed the proportion receiving curative and palliative radiotherapy and found a noticeable change in the distribution. Of all cancer patients in 1984, 17% received curative and 22% palliative radiotherapy. The corresponding figures for 1995 were 23% curative and 19% palliative radiotherapy. Two other Canadian studies have analysed the proportion of tumour patients receiving radiotherapy with palliative intent in the final phase of their lives. Of almost 200 000 patients from Ontario who died in 1986–1995, 26% were given palliative radiotherapy during their last two years (11). Of just under 10 000 patients from Nova Scotia who died in 1994–1998, 24% received radiotherapy during the last 9 months of their lives (10). Both studies found that lower age, higher socioeconomic status, and living close to a radiotherapy clinic increased the probability of receiving radiotherapy. Furthermore, the proportion of patients receiving radiotherapy varied depending on the diagnosis and the clinic giving the treatment.

*Conclusions.* Altogether, this international comparison suggests that radiotherapy at the time of the previous SBU survey was less utilized in Sweden than in other countries. The present survey shows that the proportion of patients receiving radiotherapy has increased dramatically and now seems to be on a level comparable to that reported from other countries.

#### *Head and neck cancer*

*Current practice according to survey of 2001.* Approximately 1 000 tumours of the head and neck were diagnosed in 2000, which is slightly more than in 1992. Nearly all cases received radiotherapy, 90% given with curative intent. Treatment with radiotherapy alone was given in 46% of cases, radiotherapy combined with surgery in 42% (in a few cases also with chemotherapy), and radiotherapy in combination with chemotherapy in 12% of cases. In 27% of cases a hyperfractionated radiotherapy was delivered.

For cancers of the oral cavity, radiotherapy was combined with surgery in 60%, mainly postoperative, and with chemotherapy, both induction and concomitant, in 11% of cases. In 10% of treatments interstitial brachytherapy was used. Approximately a third of oropharyngeal cancers were also treated with surgery. A third of patients receiving radiotherapy had induction chemotherapy as well. Ten percent of cases were treated with brachytherapy. Most patients with nasopharyngeal carcinoma received radiotherapy in combination with induction or concomitant chemotherapy. Half of the patients with cancer of the

hypopharynx had radiotherapy alone and the rest also had surgery. None of these patients received chemotherapy. All patients with laryngeal carcinomas received radiotherapy and a quarter also had surgery. None of these patients received chemo- or brachytherapy.

Compared with the previous study, hyperfractionation, brachytherapy and chemo-radiotherapy as treatment methods have been included in the clinical routine. The average target dose was the same, but the average number of fields has increased, indicating more complex treatments.

*Previous literature review (17).* The literature review confirms that radiotherapy is an important method for curative treatment and organ preservation in treating tumours in the head and neck region. This finding coincides with the practice in Sweden, a practice thus supported by the international literature. However, none of the patients in Sweden received complementary brachytherapy, a practice supported by the literature for specific indications. Only a few patients have received hyperfractionated treatment. According to the literature review, up to half of the patients in this tumour group would benefit from hyperfractionated treatment.

Brachytherapy is used extensively internationally, mainly for tumours in the tongue, floor of the mouth, and tonsils, and the literature review reports good treatment results. However, the value of this therapy depends on the familiarity of the radiotherapist with the method, and on the quality of the external radiotherapy which it complements, i.e. the need for complementary brachytherapy increases as the quality of external radiotherapy decreases.

Several studies show that the curative figures are significantly better for hyperfractionated radiotherapy, mainly for mid-sized tumours. Immediate side effects from treatment may be accentuated, but late side effects do not appear to increase. Presumably, half of the patients receiving radiotherapy would benefit from hyperfractionation techniques. Hyperfractionated radiotherapy creates major demands both on personnel resources and on radiotherapy capacity.

*Present literature update (18).* A changed fractionation pattern may possibly give increased tumour control but with an increase in acute side effects. Our knowledge of late side effects is still inadequate.

Concomitant chemotherapy increases local control and probably increases survival but at the same time gives severe side effects. Late side effects cannot yet be assessed. Larynx preservation is possible in 50% of the patients who survive for 5 years with hypopharyngeal cancer when radiotherapy is combined with neo-adjuvant chemotherapy.

There is some evidence to suggest that concomitant chemotherapy is better than neo-adjuvant chemotherapy together with radiotherapy of endemic nasopharyngeal carcinoma. Several randomized studies with accelerated

radiotherapy as well as the combination of radiotherapy with chemotherapy are in progress.

Both external beam radiotherapy and brachytherapy are established methods and are proven to be effective. No conclusions can be drawn regarding their relative effectiveness as no comparative randomized studies have been reported.

Several studies with radioprotectors have been reported. It has not been shown whether the parotid glands can be protected in any way that is significant for the patient. Whether or not the therapeutic ratio is improved by this method is still to be proven.

*Conclusions.* The previous report concluded that radiotherapy will continue to play a decisive role in the treating of these tumour diseases. Technical advances quite likely mean increased potential for local tumour control with fewer pronounced side effects. It was also estimated that if international brachytherapy rates were applied to patients in Sweden, an estimated 10% would be candidates for treatment. These conclusions are verified by the present survey. Combination therapy with chemotherapy has shown increased tumour control and has probably improved survival, but also increased side effects. Studies concerning accelerated radiotherapy are in progress. Thus, treatment today conforms to the scientific evidence.

#### *Oesophageal cancer*

*Current practice according to survey of 2001.* In the year 2000, almost 400 new cases of cancer of the oesophagus were diagnosed. Three-quarters of these patients received radiotherapy, 40% of them with curative intent. For radiotherapy of the primary tumour, this was combined with surgery (18%) and chemotherapy (32%). Surgery was usually carried out after radiotherapy, while chemotherapy was given before and concomitant with radiotherapy.

*Present literature update (19).* Oesophageal cancer was not included in the survey in 1992, which means that no comparison with earlier conclusions can be made. Surgery is the first treatment of choice for this cancer. If surgery is not possible it can be stated that concomitant chemo-radiotherapy gives better survival than conventional radiotherapy alone. It has been shown that pre- or postoperative radiotherapy does not increase survival compared with surgery alone.

*Conclusions.* Radiotherapy in conjunction with curative surgery for oesophageal cancer has no support in the literature. Combined chemo-radiotherapy for inoperable cancer is probably of some value. Fourteen percent of patients (16% with curative intent) participated in clinical trials.

#### *Rectal cancer*

*Current practice according to survey of 2001.* About 1 900 new cases were diagnosed in the year 2000, the same

number as in 1992. Fifty-six percent of patients received radiotherapy, 80% of them with curative intent (3% of these with radiotherapy alone and 93% as a combination therapy). Only 17% were treated for locoregional recurrence or metastases. Radiotherapy as a part of combination therapy was in practically all cases given preoperatively and then usually with 25 Gy in 5 fractions. Some cases were treated with 50 Gy in 25 fractions. Compared with the 1992 survey, the proportion of patients receiving radiotherapy was nearly doubled, and treatment with curative intent increased from 50% to 80%. The practice of preoperative radiotherapy with few fractions and high fraction dose was widely adopted.

*Previous literature review (20).* The significance of local control of rectal cancer for retained quality of life was established. The literature review showed that preoperative radiotherapy reduces the risk of recurrence and extends the time before it appears. Research has been unable to show that it influences survival time, and among elderly patients (over 80 years) preoperative radiotherapy increases the risk of fatal cardiovascular complications postoperatively. Preoperative treatment may convert tumours that are primarily assessed as inextirpable, into extirpable tumours.

*Present literature update (21).* The conclusions of the previous report regarding the significance of preoperative radiotherapy have been confirmed. Preoperative radiotherapy is more efficient than postoperative radiotherapy. It also seems that preoperative radiotherapy increases survival to a certain extent (~10%). During the past few decades improved surgical techniques (the TME concept) have been introduced. With this technique the local recurrence rate has been significantly reduced. Moreover, with this technique it has been possible to show, in a randomized study, a reduction of local recurrences with the use of preoperative radiotherapy. However, the follow-up of this randomized study is not yet long enough to enable conclusions to be drawn about the influence on the survival rate. This means that even after improved surgical techniques, preoperative radiotherapy should be used as a routine method.

In the case of inoperable rectal cancer, it has been convincingly shown that in a significant group of patients radiotherapy can render the disease operable and therefore can be recommended. Whether chemo-radiotherapy is more efficient than radiotherapy alone is not clear. For patients not amenable to surgery, radiotherapy is frequently effective for relief of symptoms.

*Conclusions.* The results of the previous survey suggest that radiotherapy for rectal cancer was under-utilized in Sweden, both as preoperative treatment and as palliation of locoregional disease. The present survey shows that the use of preoperative radiotherapy has increased from a third to half of all newly diagnosed patients. However, radiotherapy still seems to be too restricted.

### Lung cancer

*Current practice according to survey of 2001.* In the year 2000, almost 3 000 new cases of lung cancer were diagnosed in Sweden, an increase by 17% since 1992. Sixty-eight percent of patients received radiotherapy, in 25% of them with curative intent. Treatment to the primary tumour was given in 46%, one-third of those with radiotherapy alone, and two-thirds with radiotherapy combined with chemotherapy. Only in a few cases was radiotherapy combined with surgery. Ten percent of patients received hyperfractionated therapy. In 5 out of 224 treatments prophylactic treatment of the central nervous system was given.

Small cell lung cancer (SCLC) constituted 13% of cases. All received chemotherapy, half of them as induction and the rest induction plus concomitant. Approximately half of cases with non-small cell lung cancer (NSCLC) also received chemotherapy, most of them as induction therapy.

Palliative treatment was given to 54% of the cases, approximately half of them to skeletal metastases, a third to brain metastases, and the remainder to other metastatic sites such as lymph nodes, skin, adrenal glands, etc. Compared with the survey of 1992, the proportion of patients who received radiotherapy increased from 56% to 68% and treatment with curative intent increased from 17% to 25%.

Treatment of the primary tumour increased from 31% to 46%. Hyperfractionated radiotherapy was used in a few cases. If the primary tumour was irradiated with palliative intent, treatment was in many cases given as hypofractionated therapy, e.g. 3 Gy in 10–13 fractions.

*Previous literature review (22).* The literature review shows that primary treatment for NSCLC stages I and II should be surgery, and the value of postoperative radiotherapy is not established. If primary surgery cannot be performed, radiotherapy may be an alternative. Tumours at stage III are generally not primarily operable. Radiotherapy, possibly in combination with chemotherapy, marginally improves 2- and 3-year survival, but not 5-year survival. This improvement is, however, so slight that for good reasons the routine use of radiotherapy for stage III NSCLC must be questioned.

For limited SCLC, both radiotherapy and chemotherapy achieve rapid response, but with rapid recurrence and poor survival. The literature review shows that radiotherapy added to chemotherapy can increase 3-year survival from 9% to 14%, and recent figures, although based on a relatively short follow-up, suggest a further increase to nearly 30%. Since recurrence appears rapidly, 3-year survival can probably be considered permanent cure. The prognosis is worse for extensive disease, and published data do not show that radiotherapy improves survival.

*Present literature update on non-small cell lung cancer (23).* After radical surgery for NSCLC, radiotherapy does not improve survival. For medically inoperable patients

with lung cancer stages I and II, radiotherapy can lead to cure in 15–20% of cases. For tumours not removable by surgery, chemotherapy, either before or concomitantly with radiotherapy, gives improved survival compared with radiotherapy alone. In squamous cell carcinomas, hyperfractionated accelerated radiotherapy possibly gives a better rate of survival than conventional radiotherapy. The literature provides no support for elective radiotherapy of lymph glands with large fields being superior to treatment with radiotherapy to the primary tumour alone.

The palliative effect of radiotherapy for symptoms associated with intrathoracic tumours is good. Schedules with one or two large fractions may be as effective as conventional schedules with 10–13 fractions in terms of palliation of symptoms. Endobronchial brachytherapy is probably not superior to external beam radiotherapy.

*Conclusions.* Radiotherapy is of value when lung cancer cannot be removed surgically. In this situation, combined chemo-radiotherapy is superior to radiotherapy alone. Current practice is thus supported by the scientific evidence, but this is not true of postoperative treatment, which is given in a few cases. Hyperfractionated radiotherapy was given in 10% of cases, but the scientific support for this is sparse.

Palliative radiotherapy with a short treatment time (hypofractionation) is used and is supported by the literature. The data from the 1992 survey suggested an under-utilization of radiotherapy as palliative treatment for lung cancer. Even though the use of radiotherapy has increased, it might still be under-utilized for palliative treatments.

### Soft tissue sarcomas

*Current practice according to survey of 2001.* This group of tumours is relatively unusual, with not quite 300 new cases diagnosed per year. The survey shows that most cases receive radiotherapy, half of them in conjunction with primary treatment and then usually in combination with surgery as postoperative therapy. Palliative treatments are mostly given for lymph node metastases and lung metastases.

In the previous survey it was found that 90% of these patients were given radiotherapy to approximately, one-quarter as part of primary treatment and three-quarters for recurrent or metastatic disease.

*Previous literature review (24).* The literature survey showed that radiotherapy is of value, but the proportion of patients is, nevertheless, unexpectedly high. For soft tissue sarcomas of the arms and legs (comprising one-third of sarcomas) radiotherapy is not indicated after radical surgery.

*Present literature update (25).* Several randomized studies showed the value of adjuvant radiotherapy after both radical and microscopic non-radical surgery for local

control of highly malignant soft tissue sarcoma localized in the legs or trunk. It has not been shown whether pre- or postoperative radiotherapy should be preferred. Preoperative radiotherapy seems to cause more wound complications. At other anatomical sites the value of adjuvant radiotherapy is more uncertain.

*Conclusions.* The proportion of patients with soft tissue sarcoma receiving radiotherapy is still very high, and radiotherapy is now usually employed in the primary treatment. This increased use is supported by the scientific evidence.

### *Breast cancer*

*Current practice according to survey of 2001.* In the year 2000, about 6 300 new cases of breast cancer were diagnosed, an increase of 21% since 1992. Eighty-one percent of breast cancer patients received radiotherapy at some time during their disease. Radiotherapy of the primary tumour was given to half of all newly diagnosed patients with invasive cancer and a fourth of cases with cancer in situ.

In most cases radiotherapy was given postoperatively. In 70% of cases systemic therapy (chemotherapy or hormonal therapy) was also given. Radiocastration was performed in a few cases. Almost all primary treatments followed national or regional guidelines, and 13% participated in non-radiotherapy trials.

Treatment of local recurrence was given in 4% of the cases and treatments of distant metastases in 31% of the cases. The skeleton was the most common metastatic site, and breast cancer represents the largest group (38%) among patients with bone metastases. In addition, metastases to the brain, lymph nodes, skin and fundus of the eye were not uncommon.

Breast cancer accounts for a third of all radiotherapy given in Sweden. Compared with the survey of 1992, no significant change in practice was observed apart from the use of a treatment schedule with high fraction doses at two departments. According to a personal communication, this treatment is used because of the shortage of resources but only delivered to right-sided lesions (to avoid giving unnecessarily high doses to the heart).

*Previous literature review (26).* The literature is extensive and includes many randomized studies. The primary treatment usually involves surgery combined with postoperative radiotherapy. Radiotherapy after mastectomy reduces the number of local and regional recurrences. However, if radiotherapy is given only after recurrence has been diagnosed, lasting local cure is rare. Radiotherapy in conjunction with breast-conserving surgery significantly lowers the risk of local recurrence. No differences in survival have been observed. For advanced inoperable tumours, radiotherapy, chemotherapy and various types of hormonal therapy are valuable. Radiotherapy is also of value in treating distant metastases, mainly in bone and the brain.

*Present literature update (27).* Since the previous report, many randomized studies have been published. The earlier conclusions that postoperative radiotherapy after mastectomy reduces the incidence of recurrence and death from breast cancer have been confirmed. However, it is still uncertain whether postoperative radiotherapy after mastectomy increases total survival, since irradiated patients have been shown to have an excess mortality from other diseases, probably cardiovascular diseases. It is possible that the modern radiotherapy technique has less cardiovascular affect, but there is no definite scientific documentation of this as yet.

For radiotherapy after breast-conserving surgery, the earlier conclusions have also been confirmed, that postoperative radiotherapy to the breast parenchyma gives the same results as when mastectomy is performed, in terms of local recurrences, recurrence-free survival, and overall survival. A radiation boost to the tumour bed is associated with a significant decrease in the risk of ipsilateral breast recurrence, especially in women under 50 years of age.

The earlier conclusion that postoperative radiotherapy after conserving surgery for DCIS significantly decreases ipsilateral recurrences has been confirmed.

*Conclusions.* The survey of 1992 concluded that radiotherapy is valuable in primary treatment of breast cancer, and this conclusion remains unchanged. The number of breast cancer cases will most probably continue to increase and thus require more radiotherapy resources in the future. Except for the high fraction dose scheme, radiotherapy is given to the primary tumour in accordance with the scientific evidence. There is evidence that radiation boost to the tumour bed after breast-conserving surgery is valuable. It should be noticed that this technique is not used in Sweden.

### *Cancer of the uterine cervix*

*Current practice according to survey of 2001.* The incidence of cervical cancer continues to decline, and 450 cases were diagnosed in the year 2000. Eighty-three percent of patients received radiotherapy. About 90% received treatment to the primary tumour with curative intent, a third as postoperative radiotherapy and two-thirds as radiotherapy alone. Fifty-six percent of patients were given external beam therapy alone, brachytherapy alone to 13%, and a combination of the two methods in 31%. In a third of patients, chemotherapy was also given.

The previous survey showed that two-thirds of newly diagnosed patients receive curative radiotherapy. This was given as external radiotherapy in 44% of cases, as intracavitary brachytherapy in 26%, or as combination therapy in 30% of the patients.

*Previous literature review (28).* The literature showed that in the early stages with small tumour volumes, the results were the same for surgery and radiotherapy alone.

Postoperative radiotherapy may be justified for lymph node metastases. For more advanced stages, radiotherapy alone or in combination with surgery is the dominant treatment method. The literature review supports curative radiotherapy in a high percentage of patients.

*Present literature update (29).* Compared with the earlier report it can now be concluded that concomitant radiochemotherapy in the early stages of cervical cancer with poor prognosis gives better overall and disease-free survival than treatment with radiotherapy alone. There is no strong evidence that this is true in locally advanced stages. External radiotherapy in combination with brachytherapy probably gives the same result as surgery alone in early cervical cancer.

With brachytherapy it seems that a high dose rate has the same effect as a low dose rate but causes fewer side effects from the rectum.

*Conclusions.* The proportion of patients receiving radiotherapy has increased. The use of brachytherapy has declined. Concomitant radiotherapy and chemotherapy, which is supported by the evidence, is used in a third of cases.

#### *Cancer of the uterine corpus (endometrial cancer)*

*Current practice according to survey of 2001.* Cancer of the uterine mucosa (endometrial cancer) is diagnosed in about 1 300 patients annually. Two-thirds receive radiotherapy, which in more than 90% of cases is given with curative intent. In practically all cases the treatment is given postoperatively. External beam therapy alone was given in 41%, brachytherapy alone in 34%, and a combination of the two treatment methods in 25% of cases; about 16% also received chemotherapy.

*Previous literature review (30).* Endometrial cancer is a radiosensitive tumour type, and it has been shown that 70% of the patients at early stages can be cured by radiotherapy alone. Later, it was shown that combination therapy with preoperative brachytherapy and surgery yielded even better results in high-risk patients with lymph node metastases or other unfavourable prognostic factors. Patients at stage I comprise almost half of the cases, and the scientific literature provides no guidance on whether primary surgery or primary brachytherapy is preferable in these patients. The trend in Sweden, mainly during the past 2 years, has been more towards surgery in order to stage the disease surgically. Hence, the need for brachytherapy is declining.

The value of preoperative radiotherapy has been documented for early stages in high-risk patients with lymph node metastases or other unfavourable prognostic factors, and as the only treatment method for patients whose tumours cannot be removed by surgery and in cases of recurrence.

At the time of the 1992 survey, radiotherapy continued to play a major role in Sweden, often as a complement to surgery.

*Present literature update (31).* The conclusions from the earlier report are still valid, which means that radiotherapy can be given to patients who are medically inoperable or have recurrence, but the primary treatment is surgery. Whether or not adjuvant radiotherapy should be given to high-risk patients is still an open question.

*Conclusions.* The use of radiotherapy has declined in the treatment of endometrial cancer. This practice is in accordance with the FIGO recommendations but is not supported by the scientific literature.

#### *Ovarian cancer*

*Current practice according to survey of 2001.* Approximately 900 cases are diagnosed annually. Fourteen percent receive radiotherapy, of which 23% is given with curative intent. Most of the treatments are thus directed to distant metastases, mainly in lymph nodes and brain.

*Previous literature review (32).* Based on the literature, surgery and chemotherapy are the main treatment methods. Radiotherapy can be valuable for treating minimal tumour residuals after surgery or chemotherapy.

*Present literature update (33).* Radiotherapy plays a minor role for this type of cancer. It is now agreed that adjuvant radiotherapy is not needed for well-differentiated stage IA ovarian cancer (low risk), but the level of evidence is low. There are no studies of adjuvant treatment of high-risk patients in early stages.

Postoperative radiotherapy is possibly of value after radical surgery for advanced ovarian cancer. No randomized study of the value of radiotherapy after non-radical surgery has been reported.

*Conclusions.* The previous report expressed the view that radiotherapy was utilized more than could be justified scientifically. Radiotherapy was expected to continue its role as consolidation treatment and as palliative treatment. The use of radiotherapy for curative purposes has decreased, which is not contradicted by the literature.

Today, radiotherapy for ovarian cancer mainly plays a role as palliative treatment of metastatic disease.

#### *Prostate cancer*

*Current practice according to survey of 2001.* Prostate cancer is the most common type of cancer in men, and 7 600 new cases were diagnosed in the year 2000, which is an increase by 40% since the previous survey.

Half of patients with prostate cancer receive radiotherapy, of which 45% is given with curative intent. The most common treatments are either external beams to a target dose of 70 Gy in 35 fractions, or external beams of 50 Gy in 25 fractions combined with 20 Gy brachytherapy. Almost a third of primary treatments were given with this combina-

tion therapy. Brachytherapy was usually given with a high dose rate as temporary interstitial treatment, but at a single department it was also given as an interstitial permanent implant.

Palliative radiotherapy was given mainly to skeletal metastases. For locally advanced tumours hypofractionated therapy with 21 Gy in 3 fractions for one week is practised in a few institutions.

Three-quarters of patients with prostate cancer treated for primary tumours also received hormone therapy. Prophylactic irradiation of the mammary glands was given to half of these patients before the start of hormonal therapy. This practice varies widely between departments.

Compared with the survey of 1992, practice has changed dramatically. Treatment with curative intent has increased from 17% to 45% and radiotherapy of the primary tumour has quadrupled. Brachytherapy has been introduced as a routine therapy method, both as high-dose temporary and low-dose permanent implants.

*Previous literature review (34).* The literature contained no reliable information concerning the effects of radiotherapy at early tumour stages in relation to surgery or watchful waiting alone. Patients irradiated for more advanced tumours (T3) may have disease-free, 15-year survival in 18% to 27% of cases, but the same might apply to untreated patients. Controlled studies based on randomized patient data were lacking. Radiotherapy had been shown to provide excellent palliation and reduce troublesome, subjective symptoms. The conclusion in 1993 was that the current state of knowledge required one to question whether any form of curative treatment was indicated for prostate cancer, apart from less common, poorly differentiated tumours that are generally radiosensitive. Comparing practice and science suggested that not all curative therapies found support in the literature, but that opportunities for valuable palliative treatment were probably yet to be found. Overall, it was difficult to judge whether Sweden over- or under-utilized radiotherapy for prostate cancer.

*Present literature update (35).* The possibility to draw firm conclusions about treatment of prostate cancer was limited in the earlier report because of lack of randomized studies. No such studies have been conducted yet, comparing radiotherapy with check-ups alone. Ongoing studies are expected to give more information. PSA (prostate-specific antigen) and histopathological Gleason scoring have been available especially during the past decade as prognostic factors, and PSA has also been used as an indicator of treatment result. The lack of these factors in old studies has limited their value, but more detailed information can be expected from new studies.

It has been much discussed whether surgery or radiotherapy should be preferred when prostate cancer is localized. Only one small, early randomized study has been conducted, but the results are difficult to evaluate.

Results from later, non-randomized studies suggest that the results of treatment are equivalent as regards total survival for the two treatment modalities. Three-dimensional conformal radiotherapy, as well as decreasing treatment volumes, probably decreases rectal complications compared with conventional radiotherapy. With these techniques it has also been possible to perform dose escalation, which seem to give less local recurrence but no survival benefit for certain high-risk patients. Another way to give dose escalation is to add high-dose rate brachytherapy. One cannot conclude from the literature which method of dose escalation is to be preferred.

Neo-adjuvant and concomitant hormonal therapy with radiotherapy results in a significant increase in local control and disease-free survival. A corresponding effect has also been shown in adjuvant hormonal therapy (including orchidectomy) after radiotherapy for locally advanced disease.

Treatment with high-LET radiation has not shown any benefit compared with conventional radiotherapy.

*Conclusions.* The pronounced increase in incidence is probably due to the widespread use of PSA testing, a practice not supported by scientific evidence. Major changes in treatment practice have occurred without firm support in the literature, but studies are in progress. More treatments are given for primary tumour. Brachytherapy has been adopted as a routine treatment modality as well as adjuvant hormonal therapy.

#### *Urinary bladder cancer*

*Current practice according to survey of 2001.* About 2000 new cases of bladder cancer were diagnosed in the year 2000. Seventeen percent of the patients received radiotherapy, given with curative intent in a third of them. Treatment to the primary tumour was given in about 60% of cases. Slightly more than half of treatments were given with radiotherapy alone, and when combined with surgery the radiotherapy was given postoperatively. About 15% of patients received chemotherapy, mainly before or during radiotherapy. Hyperfractionated radiotherapy was given in 15% of cases.

Treatment to locally recurrent disease was given to approximately 12% of patients. The majority of treatments to metastatic disease were given for skeletal metastases.

Compared to the survey of 1992, the proportion of treatments with curative intent has decreased. The proportion with radiotherapy alone and radiotherapy in combination with surgery is about the same. Hyperfractionation is now used in some cases.

*Present literature update (36).* Urinary bladder cancer was not investigated in the 1992 survey. Surgery has been the primary treatment during the past few decades. No randomized trial comparing surgery and radiotherapy has been performed. Preoperative radiotherapy in combination

with cystectomy compared with cystectomy alone has not been shown to improve survival.

Hyperfractionated radiotherapy seems to be significantly better than conventional fractionated radiotherapy. Different trials with radiation response modifiers have been performed. In no case was it possible to demonstrate improved survival compared with conventional treatment.

Palliative radiotherapy of invasive bladder cancer can rapidly relieve symptoms. This treatment can be given hypofractionated (e.g. 21 Gy in 3 fractions for a week), but the risk of late side effects in patients with longer survival increases.

It is still uncertain whether radiotherapy combined with chemotherapy increases the possibility of conserving the urinary bladder without impairing survival compared with radiotherapy or surgery alone.

*Conclusions.* Current practice seems largely to agree with the scientific documentation. It is possible that more patients should be treated with hyperfractionated radiotherapy. The scientific documentation concerning radiotherapy for cancer of the urinary bladder is inadequate. No patients in Sweden were included in any randomized study.

#### Primary brain tumours

*Current practice according to survey of 2001.* Approximately 1 000 new cases of brain tumour were diagnosed in the year 2000 and about a third received radiotherapy, 90% to the primary tumour and 10% to locally recurrent disease. The intent of therapy was regarded as curative in about half the cases. Radiotherapy was given postoperatively in two-thirds of the treatments. Induction chemotherapy with radiotherapy alone was used in a few cases.

Compared with the previous study, the intent of treatment as curative decreased from 71% to 53%. In the 1992 survey gliomas were not divided into high-grade and low-grade malignancies.

*Previous literature review (37).* About half of the primary brain tumours are high-grade malignant glioma (glioblastoma). Several studies show that postoperative radiotherapy can extend survival by weeks to months, and is more effective than chemotherapy. However, the value of subjecting patients to prolonged and often arduous postoperative radiotherapy to extend life by only a few weeks could be questioned. As short-term palliative treatment, radiotherapy has some value in special cases, e.g. for relieving severe headache.

Low-grade malignant glioma (astrocytoma) accounts for slightly less than 20% of brain tumours. These tumours have a prolonged course, and more than half of the patients are still alive 5 years after diagnosis. Primary treatment is surgery, and the value of postoperative radiotherapy has not been scientifically proved.

Meningioma originates in the meninges and represents approximately 30% of brain tumours. Primary treatment is surgery, but two retrospective studies show that postoperative radiotherapy after non-radically resected tumours substantially reduces the recurrence risk. It must therefore be considered indicated when the radicality of surgery is uncertain.

*Present literature update (38).*

*Highly malignant glioma.* There is no curative treatment for highly malignant glioma. Postoperative radiotherapy seems to prolong survival by 3–4 months compared with chemotherapy or the best possible care after operation. Hypofractionated radiotherapy for palliative purposes is well tolerated and the effect is equivalent to that obtained by conventional radiotherapy.

*Low-grade malignant glioma.* There is no scientific evidence yet that radiotherapy prolongs life for patients with low-grade glioma. Radiotherapy can possibly be used to treat symptoms.

*Meningioma.* There is no new important study to report and therefore no change in the earlier conclusion that postoperative radiotherapy can be beneficial after subtotal resection.

*Conclusions.* The proportion of patients with primary brain tumours who receive radiotherapy has increased but the proportion receiving it for curative purposes is smaller. Palliative treatment with few radiation fractions was given only to a small proportion of the patients, which suggests that hypofractionated radiotherapy is under-utilized.

Postoperative radiotherapy is also given for low-grade astrocytoma. There is no support in the literature for this treatment.

#### Malignant lymphomas

*Current practice according to survey of 2001.* In the year 2000, 180 new cases of Hodgkin's lymphoma (HL) and 1 340 cases of non-Hodgkin's lymphoma (NHL) were diagnosed. Forty-seven percent of cases with HL and 39% with NHL received radiotherapy. Two-thirds of the lymphomas were given radiotherapy with curative intent. Nearly all patients with HL and about half of the patients with NHL received chemotherapy before radiotherapy. A few patients received total body irradiation.

In comparison with the previous survey, the proportion of patients with malignant lymphoma receiving radiotherapy was reduced by a third. The proportion of treatment with curative intent increased.

*Previous literature review (39, 40).* According to the literature, radiotherapy was the dominant treatment for early stages of HL. Chemotherapy dominated at more advanced stages, but radiotherapy was a beneficial addition in selected cases, both in conjunction with primary treatment and also later for recurrence. Treatment results were excellent.

Radiotherapy alone is superior for treating both low- and high-grade malignant forms of NHL at stage I, while at other stages and for certain forms of NHL it is of value only in selected cases. Radiotherapy also played an important role in palliative treatment.

*Present literature update (41, 42).*

*Hodgkin's lymphoma.* The role of radiotherapy in HL is decreasing. Knowledge of serious long-term sequelae has changed treatment strategies in early and intermediate stages. Long-term follow-up reveals that after 15 to 20 years the mortality in HL is exceeded by other causes of death, mostly secondary solid cancers and cardiac deaths.

The majority of younger patients with HL are cured by short-term chemotherapy followed by radiotherapy to a limited treatment volume. The optimal radiation dose and volume after chemotherapy are not defined, and there is debate concerning whether irradiation is needed at all. A thorough long-term follow-up is essential to evaluate the effects of this treatment strategy. In more advanced disease there is no scientific evidence to show that adjuvant radiotherapy after successful chemotherapy improves survival.

*Non-Hodgkin's lymphoma.*

*Indolent lymphomas.* One-third to half of patients in stage I seem to be cured by radiotherapy, according to studies with a follow-up of more than 15 years. Radiotherapy to large volumes is not superior to radiotherapy to limited fields, and the addition of chemotherapy does not improve survival. The optimal radiation dose is not defined. As regards the value of radiotherapy for advanced lymphomas, the previous conclusions stand, since no new studies have been reported. Promising results have been shown by several phase I and II studies of radioimmunotherapy in patients with disease that is recurrent or no longer responding to conventional treatment.

*Aggressive localized lymphomas.* Half of patients in stage I are cured by radiotherapy alone. Combined treatment with chemotherapy followed by radiotherapy may possibly give a better outcome than each treatment modality alone. The value of radiotherapy after chemotherapy in advanced stages has not been established.

*Primary extranodal NHL.* The treatment for these lymphomas varies depending on the localization. A complete summary of the literature would take up too much space here. Only a few examples will be given.

*Primary CNS lymphomas.* Radiotherapy alone induces a response of short duration and is associated with serious side effects on the nervous system. Younger patients treated with primary chemotherapy (including high-dose methotrexate) followed by radiotherapy show longer survival. For patients above 60 years of age, combined therapy of this kind has severe side effects on the CNS.

*MALT lymphomas.* The optimal treatment of gastrointestinal lymphoma is not fully established. For indolent

MALT lymphomas (mucosa-associated lymphoid tissue) in the ventricle, treatment of the *Helicobacter pylori* bacteria is the first treatment measure.

*Conclusions.* The present survey shows significant changes in treatment, above all for HL. This is supported by the scientific literature.

#### *Skeletal metastases*

*Current practice according to survey of 2001.* Skeletal metastases are the most common indication for palliative treatment. Cancer of the prostate, breast and lung are the predominant diagnoses among patients treated for skeletal metastases. At least 5 000 treatments for skeletal metastases are given annually, corresponding to 11% of newly diagnosed patients (less autopsy findings) with tumour diagnoses in Sweden. Of individual cancer types, 25% of prostate cancer patients, 20% of breast cancer patients and 19% of lung cancer patients will receive palliative radiotherapy for skeletal metastases during the course of the disease. Related to the total prevalence, 4.7% of prostate cancer cases, 1.8% of breast cancer cases, and 10.0% of lung cancer cases would be candidates for palliative radiotherapy for bone metastases during a year.

On average, radiotherapy for skeletal metastases was given using 18 Gy in 4.4 fractions with 1.6 fields. A large proportion of patients received 6–8 Gy in a single fraction.

Compared to the survey of 1992, the number of treatments with radiotherapy for skeletal metastases has increased by 40%, this still accounts for basically the same proportion of palliative treatments against recurrent and metastasizing disease. In the earlier report it was assumed that 15% of treatments to bone metastases could be given with one fraction, 60% with 5 fractions and 25% with 10 fractions. The present survey showed that the figures are 37%, 36% and 14%, respectively. Thus, a much more efficient treatment policy has been adopted.

*Previous literature review (43).* The literature showed that radiotherapy is an effective treatment method to reduce pain, prevent fracture and to give patients better mobility. The most appropriate fractionation was unclear, whether 1, 5, or 10 treatments should be used. The literature suggested that the effect of radiotherapy depended on a range of factors, including the localization of the skeletal metastases.

*Present literature update (44).* Local radiotherapy has a pain-relieving effect in 80% of all cases that persist for more than half a year for 50% of the cases. It has been clearly shown that the effect and its duration are not dependent on the fractionation pattern used. Fracture or lesion of the spinal cord is unusual in irradiated areas. Systemic radiotherapy with radionuclides has shown an effect in generalized skeletal pain in 60–80% of patients, above all with breast and prostate cancer with a duration of 2–4 months.

Rapid diagnosis and early radiotherapy for spinal cord compression are the most important factors for a favourable outcome after radiotherapy.

Multifraction, rather than single fraction, radiotherapy results in better re-mineralization of destruction evoked by osteolytic metastases.

*Conclusions.* The survey of 1992 showed that only 1 in 10 cancer patients received palliative radiotherapy for bone metastases. This proportion was lower than in other nations, and clearly represented an under-utilization when compared to figures presented in the literature. It was concluded that a substantial increase in demand for palliative treatment of bone metastases could be expected.

The present survey shows that the number of treatments for skeletal metastases has increased considerably. Treatments are given with fewer fractions thus consuming only a minor part of radiotherapy resources. There is strong support for this in the literature. It is difficult to judge whether this change in practice meets the need for palliative radiotherapy of bone metastases.

#### *Brain metastases*

*Current practice according to the survey of 2001.* The brain is one of the three most common sites for metastases. The literature shows that metastases develop in 15% to 20% of all cancer patients, which in Sweden corresponds to between 6000 and 8000 patients annually. Many do not have symptoms, and therefore most patients do not require treatment. According to the survey, slightly over 400 patients per year are treated for this indication.

In the year 2001, almost 1000 treatments for brain metastases are given. Compared to the estimate in the previous survey this is a doubling of the use of this treatment modality.

*Previous literature review (37).* The literature review shows that effective symptom relief can be achieved in approximately 70% of the patients with symptomatic brain metastases. The effects are satisfactory and lasting, even following a few high-dose treatments. Postoperative radiotherapy often prolongs survival in cases of isolated, solitary, brain metastases where surgical treatment may be indicated. For small, distinct metastases, stereotactic irradiation can lead to lasting regression and years of survival.

*Present literature update.* No literature update was made for this condition.

*Conclusions.* The survey of 1992 showed that only 1 cancer patient in 100 in Sweden received radiotherapy for brain metastases. This figure suggests an under-utilization of the treatment method. It was estimated that the need for radiotherapy for brain metastases would probably increase. The present survey suggests that a radical improvement has occurred.

## DISCUSSION

Nine years have passed between the previous survey of 1992 and the present one of 2001. Substantial changes in radiotherapy practice can be found.

There is scant international literature concerning how large a proportion of patients receive radiotherapy and how the resources are distributed between curative and palliative radiotherapy. In reports from Australia and Canada (12, 15, 16), however, one can detect a tendency towards increased use of radiotherapy. In addition, it can be seen that an increased proportion of the resources are used for curative treatment. Based on the 1992 survey, it was estimated that about 32% of all tumour cases received radiotherapy during some phase of the disease. Compared with other western countries, Sweden then seemed to be using radiotherapy to a smaller extent. The present survey arrives at a much higher estimate, that 47% of tumour cases receive radiotherapy. This figure seems to be on a par with the international figures.

It is difficult, however, to compare the use of radiotherapy between different countries solely on the basis of a crude percentage figure. Estimates like these should be interpreted with caution since they are influenced by many different factors. Problems related to point estimates per se are discussed in detail in Möller et al. (5). Other problems occur when comparing different countries. The case mix differs from country to country, although most of the cited studies concern western countries with fairly similar cancer patterns. Incidental autopsy findings and DCOs may have been included or excluded. Registries often have different rules for registering multiple tumours in the same individual, and skin cancer is not always included. Standardization to a well-defined distribution of cancer types within a reference population would be desirable, but this does not exist. An alternative for comparisons would be to calculate the proportion of irradiated patients for each individual type of cancer, perhaps divided by stage (tumour extent) and microscopic type. However, this is only partly possible for Sweden, since the stage is not reported to the national cancer registry.

One conclusion in the previous report was that radiotherapy played an important role in palliative treatment of cancer and that it was under-utilized in Sweden. Furthermore, it was pointed out that a rationalization could be accomplished by applying fewer fractions with higher doses in palliative treatment. In 1992, 50% of patients received palliative treatment. Since palliative treatment is less complicated than curative treatment, these patients consumed only 32% of the fractions and 28% of the fields. In 2001 palliative treatment was delivered to 46% of the patients using 22% of the fractions and 15% of the fields (44% of the patients and 19% of the fractions if the diagnoses are limited to the same as in 1992). The more pronounced decline in fractions as compared to patients for

palliative treatment indicates that the possibility of rationalizing palliative treatment with fewer fractions has been employed.

The most common target for palliative radiotherapy is skeletal metastases. In the 1992 survey a mean dose of 27 Gy in 8 fractions was used. It was calculated that the mean number of fractions could be reduced to 5.65. In the present survey it was found that the development has gone even further, with a mean of 17.9 Gy in 4.4 fractions being used. The possibility of further reducing the number of fractions in the treatment of skeletal metastases is limited.

Skeletal metastases are mostly multiple and many patients require more than one treatment. In the survey 1144 treatments were given due to skeletal metastases, indicating an annual figure of 5000 treatments. It is difficult to estimate the true need for this type of treatment, but with approximately 21000 individuals dying of cancer annually, the figure still seems to be low.

In palliative treatment of brain tumours the literature show that fewer fractions can be used. However, the number of patients is relatively small and such rationalization will therefore have a limited impact on the need of resources.

In curative treatment a more sophisticated therapy has been applied in the year 2001 as compared to 1992, mainly due to technical development, which allows many more fields to be used during the same machine-time. Furthermore, the dramatic increase in number of treatments and fractions correlated to the modest increase in treatment machines indicates a rationalization with a more effective use of the available equipment. A further step in the technical refinement, which will probably be applied soon, is the use of intensity modulated radiotherapy (IMRT) (45, 46). This method means that one can conform treatment even more closely to the tumour, which will, it is hoped, give fewer late side effects. However, the use of IMRT will probably consume more time per patient at the machine and thus result in fewer patients being treated per day.

In the previous report the need for preoperative radiotherapy in rectal cancer was considered uncertain, and it was believed that modern surgery would make such treatment unnecessary in most patients. The literature update shows that this is not the case. Even with modern surgery, preoperative radiotherapy reduces the number of local recurrences significantly. The present survey also demonstrates an increase in the use of preoperative radiotherapy in rectal cancer.

A special discussion is required for prostate cancer, by far the most common cancer among men, but also overall. In 1992, 5155 new cases were reported, and in the study of future cancer incidence it was estimated that the figure would increase by 25% to 6267 new cases by the year 2010. However, the increase has been substantially larger and in the year 2000, over 7600 new cases were reported. This unforeseen increase in reported incidence of the disease is

largely the result of the use of PSA testing. With a simple blood sample, the PSA value can be established and a high value might indicate a prostatic cancer. So far, there are no studies that demonstrate the benefit of PSA screening, and a previous SBU report did not recommend routine use (47). Irrespective of the lack of scientific evidence, PSA testing has been widely adopted, resulting in a very significant increase in the number of reported cancer cases. The patients detected by PSA screening are younger than the clinically diagnosed patients. Thus, the median age of patients diagnosed with prostate cancer has declined from 75 years in 1990 to 73 years in 2000. Studies are ongoing that we hope will give an indication as to whether PSA screening is valuable or not.

The conclusion of the previous literature review of prostate cancer was that the scientific literature was limited and there was considerable uncertainty concerning the best treatment policy. In early disease there was controversy about whether any treatment was better than a 'wait-and-see' strategy. There were indications that radical treatment might be beneficial in the less common group of poorly differentiated tumours. A definitive value of palliative radiotherapy in advanced disease could be established. Reflecting the uncertainty of the value of radical treatment in prostate cancer, only 81 patients were identified to receive such treatment in the 1992 survey.

Radical treatment of prostate cancer can be surgery or radiotherapy. In the case of radiotherapy it can be either external therapy or brachytherapy alone or a combination of the two. There are no randomized studies to compare the different methods. However, both surgery and radiotherapy seem to be of equal value in achieving radical therapy.

In the present literature review, good randomized studies demonstrating the value of radical treatment in early disease are still lacking. However, such studies are in progress and it is hoped they will shed more light on the issue. Irrespective of the lack of scientific support, there has been a very significant increase in the use of radical radiotherapy in prostate cancer. In the present survey 423 patients were identified. It is difficult to make a prognosis of the future development in the treatment of prostate cancer, but it might have a very significant impact on the future need for radiotherapy. There is nothing to indicate that the use of PSA testing will decline, and if a study is conducted that can demonstrate a benefit, a huge increase in the use of PSA for screening can be anticipated. A scenario with a doubling of the reported incidence of prostate cancer in 10 years' time is quite possible. The majority of the PSA-detected patients with local tumours will be relatively young and possible candidates for radical treatment. If the ongoing studies should demonstrate a benefit of radical treatment, the demand will increase dramatically and will be very difficult to meet. The resources for both surgery and radiotherapy are limited, and it is not unlikely that a

shortage of radiotherapy will affect other and weaker groups of patients.

Radical radiotherapy in prostate cancer is complicated with many fractions and fields and thus demanding large resources. When external radiotherapy alone is used, the survey shows that 70–78 Gy in 35–39 fractions are used. If a treatment machine is used exclusively for these patients, approximately 180–200 cases could be treated during one year. This figure should be compared with the possible future scenario of prostate cancer incidence.

If an estimate were to be made of the future need of radiotherapy, there is nothing in the development or in the current literature review to suggest a diminishing use of radiotherapy. The same conclusions were reached in an investigation carried out by the Swedish Cancer Society (48). Cancer incidence continues to increase, currently by just over 1% per year. If prostate cancer is excepted, a reasonable estimate is that the need for radiotherapy will continue to increase by approximately the same rate as that during the past 9-year period. Furthermore, the need for radiotherapy for prostate cancer must be considered, and—as described above—this might be very substantial.

#### ACKNOWLEDGEMENTS

The secretarial assistance by Gertrud Andersson, Oncological Centre, University Hospital, Lund is gratefully acknowledged.

#### REFERENCES

1. SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 1. A prospective survey of radiotherapy practice in Sweden. *Acta Oncol* 1996; 35 (Suppl 6): 47–56.
2. Ragnhammar P, Brorsson B, Nygren P, Glimelius B. A prospective study of the use of chemotherapy in Sweden and assessment of the use in relation to scientific evidence. *Acta Oncol* 2001; 40: 391–411.
3. SBU—The Swedish Council on Technology Assessment in Health Care. Radiotherapy for cancer. Volume 2. *Acta Oncol* 1996; 35 (Suppl 6).
4. Glimelius B, Bergh J, Brandt L, et al. The Swedish Council on Technology Assessment in Health Care (SBU) systematic overview of chemotherapy effects in some major tumour types—summary and conclusions. *Acta Oncol* 2001; 40: 135–54.
5. Möller T, Brorsson B, Ceberg J, et al. A prospective survey of radiotherapy practice 2001 in Sweden. *Acta Oncol* 2003; 42: 387–410.
6. Radiation Oncology in Integrated Cancer Management ('The Blue Book'). Report of the Inter Society Council for Radiation Oncology. December 1991. Available from AAPM, ACR, ARS, ASTRO, RRS, RSNA and NCI, USA.
7. European Strategy for Cancer Research. Europe Against Cancer. Commission of the European Communities. DG XII-Medical Division, Rue de la Loi 200, B-1049 Bruxelles. XII/F-6/nv/91001P, October 1991.
8. de Jong B, Crommelin M, van der Heijden LH, Coeberg JW. Patterns of radiotherapy for cancer patients in southeastern Netherlands, 1975–89. *Radiother Oncol* 1994; 31: 213–21.
9. Willems D, van Daal AJ. Gezondheidsraad in Dutch. Report 93/15, Zeijmegen.
10. Johnston GM, Byd CJ, Joseph P, MacIntyre M. Variation in delivery of palliative radiotherapy to persons dying of cancer in Nova Scotia 1994 to 1998. *J Clin Oncol* 2001; 19: 3323–32.
11. Huang J, Zhou S, Groome P, Tyldesley S, Zhang-Solomans J, Mackillop WJ. Factors affecting the use of palliative radiotherapy in Ontario. *J Clin Oncol* 2001; 19: 137–44.
12. Paszat LF, Mackillop WJ, Groome PA, et al. Radiotherapy for breast cancer in Ontario: rate variation associated with region, age and income. *Clin Invest Med* 1998; 21: 125–34.
13. Brodersen HJ, Heilmann HP. Radiotherapy in northern Germany: data on radio-oncology from 6 Bundeslander. *Strahlenther Onkol* 1996; 172: 649–57.
14. Teshima T, Owen JB, Hanks GE, Sato S, Tsunemoto H, Inoue T. A comparison of the structure of radiation oncology in United States and Japan. *Int J Radiat Oncol Biol Phys* 1996; 34: 235–42.
15. Barton M. Radiotherapy utilization in New South Wales from 1996 to 1998. *Australas Radiol* 2000; 44: 308–14.
16. Mackillop WJ, Zhou S, Groome P, et al. Changes in the use of radiotherapy in Ontario 1984–1995. *Int J Radiat Oncol Biol Phys* 1999; 44: 355–62.
17. Möller T. Head and neck cancer. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 22–45.
18. Zackrisson B, Mercke C, Strander H, et al. A systematic overview of radiation therapy effects in head and neck cancer. *Acta Oncol* 2003; 42: 443–61.
19. Ask A, Albertsson M, Järhult J, et al. A systematic overview of radiation therapy effects in oesophageal cancer. *Acta Oncol* 2003; 42: 462–75.
20. Blomgren H. Rectal cancer. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 64–9.
21. Glimelius B, Grönberg H, Järhult J, et al. A systematic overview of radiation therapy effects in rectal cancer. *Acta Oncol* 2003; 42: 476–92.
22. Frödin J-E. Lung cancer. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2. A critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 46–53.
23. Sirzén F, Kjellén E, Sörensson S, et al. A systematic overview of radiation therapy effects in lung cancer. *Acta Oncol* 2003; 42: 493–515.
24. Alvegård T. Soft tissue sarcomas. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 117–22.
25. Strander H, Turesson I. A systematic overview of radiation therapy effects in soft tissue sarcomas. *Acta Oncol* 2003; 42: 516–31.
26. Rutqvist L-E. Breast cancer. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: A critical Review of the Literature. *Acta Oncol* 1996; 35 (Suppl 7): 54–63.
27. Rutqvist L-E, Rose C, Cavallin-Ståhl E. A systematic overview of radiation therapy effects in breast cancer. *Acta Oncol* 2003; 42: 532–45.
28. Einhorn N, Tropé C. Cervical cancer (Cervix uteri). In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 75–80.

29. Einhorn N, Tropé C, Ridderheim M, et al. A systematic overview of radiation therapy effects in cervical cancer. *Acta Oncol* 2003; 42: 546–56.
30. Einhorn N. Uterine cancer. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 81–5.
31. Einhorn N, Tropé C, Ridderheim M. A systematic overview of radiation therapy effects in uterine cancer. *Acta Oncol* 2003; 42: 557–61.
32. Einhorn N. Ovarian cancer. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 86–92.
33. Einhorn N, Tropé C, Ridderheim M. A systematic overview of radiation therapy effects in ovarian cancer. *Acta Oncol* 2003; 42: 562–6.
34. Frödin J-E. Prostate cancer. In: SBU — The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 70–4.
35. Nilsson S, Strander H, et al. A systematic overview of radiation therapy effects in prostate cancer. *Acta Oncol* 2003; 42 (in press).
36. Widmark A, Flodgren P, Damber J-E, et al. A systematic overview of radiation therapy effects in cancer of the urinary bladder. *Acta Oncol* 2003; 42: 567–81.
37. Blomgren H. Brain tumours. In: SBU — The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 16–21.
38. Berg G, Blomquist E, Cavallin-Ståhl E: A systematic overview of radiation therapy effects in brain tumours. *Acta Oncol* 2003; 42: 582–8.
39. Gustavsson A. Hodgkin's disease. In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 93–101.
40. Gustavsson A. Non-Hodgkin's lymphomas (NHL). In: SBU—The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 102–16.
41. Gustavsson A, Osterman B, Cavallin-Ståhl E. A systematic overview of radiation therapy effects in Hodgkin's lymphoma. *Acta Oncol* 2003; 42: 589–604.
42. Gustavsson A, Osterman B, Cavallin-Ståhl E. A systematic overview of radiation therapy effects in non-Hodgkin's lymphomas. *Acta Oncol* 2003; 42: 605–19.
43. Möller T. Skeletal metastases. In: SBU — The Swedish Council on Technology Assessment in Health Care: radiotherapy for cancer. Volume 2: a critical review of the literature. *Acta Oncol* 1996; 35 (Suppl 7): 125–36.
44. Falkmer U, Järhult J, Wersäll P, Cavallin-Ståhl E. A systematic overview of radiation therapy effects in skeletal metastases. *Acta Oncol* 2003; 42: 620–33.
45. Johansson K-A, Brahme A, Carlsson J, et al and the Swedish Cancer Society Investigation Group. Radiation therapy dose delivery. *Acta Oncol* 2003; 42: 85–91.
46. Svensson H, Möller TR. Developments in radiotherapy. *Acta Oncol* 2003; 42: 430–42.
47. SBU. Massundersökning för prostatacancer. Report 126, SBU, Stockholm 1995.
48. Mattsson S, Brahme A, Carlsson J, et al. Swedish Cancer Society radiation therapy research investigation. *Acta Oncol* 2002; 41: 596–603.