Critical issues in radiotherapy

Summary

Radiotherapy is the most important type of non-surgical treatment for cancer [Tobias]. About 45–50% of all cancer patients can be cured, approximately 30–40% of these by radiotherapy, either alone or in combination with other treatment modalities such as surgery and chemotherapy. Radiotherapy is also important for the palliative treatment of cancer patients. About 50% of all cancer patients need radiotherapy, either as part of curative or palliative treatments [De Vita et al; Inter-Society Council; Vermorken and Schermer].

Considerable improvements have been seen in radiotherapy during the past decade, and more improvements can be foreseen. While technological improvements in radiotherapy are important, perhaps even more important is the developing knowledge concerning which patients can benefit the most from radiotherapy and how radiotherapy should be applied to each cancer patient.

What Is Radiotherapy and Does it Work?

Radiotherapy is treatment of malignant tumors with ionizing radiation which causes ionization and damage in important molecules, such as desoxyribonucleic acid (DNA). Ionizing radiation affects normal tissues as well as cancerous tissues. Therefore, the goal of the radiation oncologist is to lethally damage cancer tissue with a minimum of damage to healthy surrounding tissue [Tobias].

Speaking generally, there is no question that radiotherapy works, in the sense that it kills cancer cells. The two determinants of the final effects of radiotherapy on the tumor are the sensitivity of the cancer cell and the volume of the tumor. Radiotherapy reduces the size of tumors, eradicating them completely when they are small and sensitive to radiation. It can cure many different types of cancer, either alone or in conjunction with other means, especially surgery. Not all cancers can be cured by irradiation, but radiotherapy can still reduce the size of tumors, leading to reduced symptoms and improved quality of life for the cancer patient (palliation).

In the case of an individual patient, the *radiation oncologist*, in consultation with other specialists, must select the correct therapy for that individual. The selection should be based on prognostic factors and predicted effects of radiotherapy, based on clinical trials and clinical experience. These issues will be further discussed below.

What Resources Are Needed for Adequate Radiotherapy Services?

Determining the global need for radiotherapy in a healthcare system depends on knowing the number and types of cancer patients in a given region or country that may benefit from radiotherapy. Not all cancers are treated with radiotherapy, nor are all stages of a given cancer treated with radiotherapy. Given data on the incidence and prevalence of different types of cancer, one can begin to estimate the resources needed for the radiotherapy service. To do this, however, information is also needed on the indications for radiotherapy and the quality criteria that are appropriate for the given area.

The experience of different countries can help in knowing what resources are needed for a given area. However, differences can be observed in the way that different countries use radiotherapy. For example, some countries use more radiotherapy than others. Why is this so? One important reason is the difference in availability of machines from country to country, which is the consequence of a number of factors (see Tables 1 and 2, Chapter 1). One reason is the differing incidence and prevalence of cancer in different countries, because of differing age structures, genetic backgrounds, exposure to cancer causing factors, and so forth. Morbidity patterns also vary. Indications for use of radiotherapy are different in different countries. Also, use of radiotherapy does not depend alone on scientific indications for use. Acceptance of radiotherapy depends on tradition and belief in both physicians and patients. For example, social factors such as age and economic factors may influence method of treatment [Greenberg et al; Sanet et al]. Quality standards and criteria often differ from country to country. Geographic factors such as long travel distances to radiotherapy facilities may reduce the use of radiotherapy. Clinicians may not refer patients with cancer to radiotherapy because of ignorance or other factors. The abilities and technologies allowing safe and effective radiotherapy treatment may not be available, especially for economic reasons (for example, in developing countries). The important point is that fewer machines may mean longer waiting lists, less radiotherapy, and, therefore, a lower quality of care for some cancer patients.

Nonetheless, given an expected number of different types of cancer to treat, reviewing the scientific literature and taking such factors as these into account, it is possible to estimate the resources needed – the machines, buildings, people – in a particular region or country. One must estimate the number of treatment hours per machine. Planning for the numbers of people treated depends on local factors. For example, in some areas radiotherapy is delivered by technicians, but in other areas nurses carry out this function. Organizational factors, such as the legal work week, the possibility of shifts, and restrictions on use of personnel in certain ways affect the number of people needed. Economic factors such as the extent of insurance coverage can also influence the resources needed.

If the planning is well-done, and the amount of resources available inappropriate, this is the first step to a high-quality radiotherapy service. There are a number of such efforts underway in Europe and the United States. Such efforts will be further described in this report.

How Can Quality of Care Be Assured in Radiotherapy?

Quality is generally assessed by examining the structure, process, and outcomes of care.

In radiotherapy, structure is often called "infra-structure", and encompasses the machines, buildings, and people necessary for carrying out radiotherapy. In some countries, such as Belgium and the Netherlands, standards for infra-structure are part of legal requirements that must be met by any radiotherapy service.

The process of radiotherapy leads to an outcome for a patient. This process is obviously quite important, and in radiotherapy, the process is not only clinical, but is also technical and complicated. Technical standards are available for this process, dealing mainly with the dose of radiation actually given and the volume of the tumor irradiated. Assuring the quality of this technical process is recognized as a critical part of quality assurance in radiotherapy.

The process involves all actions with respect to the treatment, from the moment the patient enters a department of radiotherapy until he or she leaves it. The process depends on making a diagnosis and considering indications for treatment. Treatment planning is mostly very complex, involving the use of modern imaging techniques, definition of the target volume in three dimensional reconstructions, and careful dose calculation in the tumor and the healthy surrounding organs. For the actual treatment, precise equipment and a reliable method for beam calibrations are needed, as well as sophisticated measures for the immobilization of patients and the reproducibility of the treatment position.

All these factors are necessary for the improvement of quality. Leaving one of them out might make the treatment simpler and cheaper. However, such omissions weaken the entire treatment chain and lower the quality of care. The main issue in health care is deciding what services should be provided to a patient and to make sure that the services delivered have the highest standards.

The World Health Organization [September 1988] has stated that the major objective of quality assurance is to "improve the outcome of all healthcare in terms of health, functional ability, patient well-being, and consumer satisfaction." Quality assurance activities, then, also seek firm evidence linking a certain process of care to improved outcomes before using process measures to assess quality. Information is developing to make such linkage possible, especially from the Patterns of Care study in the United States and similar studies in Europe.

Assessing quality of radiotherapy services, through either process or outcome measures, was not often done in most countries until recently, as is the case with all of medical practice. In recent years, however, such activities have begun to grow rapidly in the United States and Europe, encouraged both by professional organizations and by governments.

What Does Radiotherapy Cost?

The general impression is that radiotherapy is quite costly to society, since the capital investments in large machines such as linear accelerators are quite visible. In fact, however, radiotherapy is not very expensive in a relative sense. In the United States, it was estimated that the total expenditure for radiotherapy was about 0.37 percent of national health expenditures [Hanks, 1992]. In Sweden, it was found that radiotherapy itself accounted for about 4 percent of the cost of all cancer therapy. Nonetheless, all resources in health care need to be effectively used. Few studies have been done examining the cost-effectiveness of radiotherapy, even though about half of all patients receive radiotherapy.

In the future, economic analyses could be of substantial assistance in planning radiotherapy services.

What Developments Are Needed in Radiotherapy Treatment?

New technologies are developing for radiotherapy. These fall into four general areas.

In *physics*, there are improvements in 1) precision of target definition through improved imaging and 2) precision of dose delivery through improved treatment delivery methods.

In *molecular biology*, research is focused on understanding individual responsiveness to radiation therapy. These results will aid in optimizing therapy by a) patient selection; b) adaptation of the treatment to the individual patient (time, dose, fractionation); and c) modification of the radiation response.

The third area of research is in the area of *randomized clinical trials*, in which new therapies are compared with best standard therapy.

The fourth area is concerned with evaluations that show *cost-effectiveness and clinical outcomes*. It will be increasingly important to collect data on quality of life measures so that quality of life assessments can be developed and made available to patients to aid them in their selection of therapy.

These important research topics need continued support to realize the optimal benefits of radiation therapy.