ICRU REPORT 29

Dose Specification for Reporting External Beam Therapy with Photons and Electrons

INTERNATIONAL COMMISSION
ON RADIATION UNITS
AND MEASUREMENTS

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(For detailed information on the availability of this and other ICRU Reports see page 19

Preface

Scope of ICRU Activities

The International Commission on Radiation Units and Measurements (ICRU), since its inception in 1925, has had as its principal objective the development of internationally acceptable recommendations regarding:

(1) Quantities and units of radiation and radioactivity,

(2) Procedures suitable for the measurement and application of these quantities in clinical radiology and radiobiology,

(3) Physical data needed in the application of these procedures, the use of which tends to assure uniformity in reporting.

The Commission also considers and makes similar types of recommendations for the radiation protection field. In this connection, its work is carried out in close cooperation with the International Commission on Radiological Protection (ICRP).

Policy

The ICRU endeavors to collect and evaluate the latest data and information pertinent to the problems of radiation measurement and dosimetry and to recommend the most acceptable values and techniques for current use.

The Commission's recommendations are kept under continual review in order to keep abreast of the rapidly expanding uses of radiation.

The ICRU feels it is the responsibility of national organizations to introduce their own detailed technical procedures for the development and maintenance of standards. However, it urges that all countries adhere as closely as possible to the internationally recommended basic concepts of radiation quantities and units.

The Commission feels that its responsibility lies in developing a system of quantities and units having the widest possible range of applicability. Situations may arise from time to time when an expedient solution of a current problem may seem advisable. Generally speaking, however, the Commission feels that action based on expediency is inadvisable from a long-term viewpoint; it endeavors to base its decisions on the long-range advantages to be expected.

The ICRU invites and welcomes constructive comments and suggestions regarding its recommendations and reports. These may be transmitted to the Chairman.

Current Program

The Commission has divided its field of interest into twelve technical areas and has assigned one or more members of the Commission the responsibility for identification of potential topics for new ICRU activities in each area. A body of consultants has been constituted for each technical area to advise the Commission on the need for ICRU recommendations relating to the technical area and on the means for meeting an identified need. Each area is reviewed periodically by its sponsors and consultants. Recommendations of such groups for new reports are then reviewed by the Commission and a priority assigned. The Technical areas are:

Radiation Therapy
Radiation Diagnosis
Nuclear Medicine
Radiobiology
Radioactivity
Radiation Physics—X Rays, Gamma Rays and Electrons
Radiation Physics—Neutrons and Heavy Particles
Radiation Protection
Radiation Chemistry
Values of Factors—*W*, *S*, etc.
Theoretical Aspects
Quantities and Units

The actual preparation of ICRU reports is carried out by ICRU report committees. One or more Commission members serve as sponsors to each committee and provide close liaison with the Commission. The currently active report committees are:

Average Energy Required to Produce an Ion Pair
C_λ and C_E
Computer Uses in Radiotherapy

Definitions and Terminology for Computed Tomography
Dose Specification for Reporting Intracavitary and Interstitial Therapy
Dosimetry of Pulsed Radiation
Fundamental Quantities and Units
High-Energy Electron Beam Dosimetry
Measurement of Low-Level Radioactivity in Humans
Methods of Assessment of Dose in Tracer Investigations
Microdosimetry
Photographic Dosimetry in External Beam Therapy
Radiobiological Dosimetry
Scanning
Stopping Power

ICRU Reports

In 1962 the ICRU, in recognition of the fact that its triennial reports were becoming too extensive and in some cases too specialized to justify single-volume publication, initiated the publication of a series of reports, each dealing with a limited range of topics. This series was initiated with the publication of six reports:

ICRU Report 10a, *Radiation Quantities and Units*
ICRU Report 10b, *Physical Aspects of Irradiation*
ICRU Report 10c, *Radioactivity*
ICRU Report 10d, *Clinical Dosimetry*
ICRU Report 10e, *Radiobiological Dosimetry*
ICRU Report 10f, *Methods of Evaluating Radiological Equipment and Materials*

These reports were published, as had been many of the previous reports of the Commission, by the United States Government Printing Office as Handbooks of the National Bureau of Standards.

In 1967 the Commission determined that in the future the recommendations formulated by the ICRU would be published by the Commission itself. This report is published by the ICRU pursuant to this policy. With the exception of ICRU Report 10a, the other reports of the "10" series have continuing validity and, since, except in the case of ICRU Report 10e, none of the reports now in preparation is designed specifically to supersede them, they will remain available until the material is essentially obsolete. All future reports of the Commission, however, will be published under the ICRU's own auspices. Information about the availability of ICRU Reports is given on page 18.

ICRU's Relationships With Other Organizations

In addition to its close relationship with the International Commission on Radiological Protection, the ICRU has developed relationships with other organizations interested in the problems of radiation quantities, units and measurements. Since 1955, the ICRU has had an official relationship with the World Health Organization (WHO) whereby the ICRU is looked to for primary guidance in matters of radiation units and measurements and, in turn, the WHO assists in the world-wide dissemination of the Commission's recommendations. In 1960 the ICRU entered into consultative status with the International Atomic Energy Agency. The Commission has a formal relationship with the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), whereby ICRU observers are invited to attend UNSCEAR meetings. The Commission and the International Organization for Standardization (ISO) informally exchange notifications of meetings and the ICRU is formally designated for liaison with two of the ISO Technical Committees. The ICRU also corresponds and exchanges final reports with the following organizations:

Bureau International des Poids et Mesures
Commission of the European Communities
Council for International Organizations of Medical Sciences
Food and Agriculture Organization
International Council of Scientific Unions
International Electrotechnical Commission
International Labor Office
International Radiation Protection Association
International Union of Pure and Applied Physics
United Nations Educational, Scientific and Cultural Organization

The Commission has found its relationship with all of these organizations fruitful and of substantial benefit to the ICRU program. Relations with these other international bodies do not affect the basic affiliation of the ICRU with the International Society of Radiology.

Operating Funds

In the early days of its existence, the ICRU operated essentially on a voluntary basis, with the travel and operating costs being borne by the parent organizations of the participants. (Only token assistance was originally available from the International Society of Radiology.) Recognizing the impracticability of continuing this mode of operation on an indefinite basis, operating funds were sought from various sources.

Financial support has been received from the following organizations:

B.A.T. Cigaretten-Fabriken GMBH
Commission of the European Communities
Council for International Organizations of Medical Sciences
Eastman Kodak Company
E. I. duPont de Nemours and Company
Ford Foundation
General Electric Company
International Atomic Energy Agency
International Radiation Protection Association

International Society of Radiology
Japan Industries Association of Radiation Apparatus
John och Augusta Perssons stiftelse
National Cancer Institute of the U. S. Department of Health, Education and Welfare
N.V. Philips Gloeilampenfabrieken
Picker Corporation
Radiological Society of North America
Rockefeller Foundation
Siemens Corporation
Society of Nuclear Medicine
Statens laegevidenskabelige Forskningsrad
U. S. Bureau of Radiological Health of the Food and Drug Administration

In recognition of the fact that its work is made possible by the generous support provided by these organizations, the Commission expresses its deep appreciation.

HAROLD O. WYCKOFF,
Chairman, ICRU

Washington, D.C.
1 March 1978

Contents

Dose Specification for Reporting External Beam Therapy with Photons and Electrons

1. Introduction

When a patient undergoes a course of radiotherapy, the radiotherapist normally records the radiation doses delivered at various points in the irradiated tissues, including both diseased and healthy tissues. This record serves a number of purposes:

a. to enable the radiotherapist to maintain his treatment policy and improve it in the light of experience;
b. to enable the radiotherapist to combine the results of his treatments with those of his departmental colleagues;
c. to enable other radiotherapists to benefit from the department's experience;
d. to enable the results of the department's treatments to be meaningfully compared with those of other centers.

It will be noted that all of these functions, except the first, are intended to facilitate communication with others. In fact, there is little purpose in recording absorbed doses if the data cannot be interpreted by other workers in the field. However, this obvious statement is far from being realized in practice. Most radiotherapists and physicists are so used to the style and conventions used in their own departments that they would be shocked to learn that their treatment reports were ambiguous, or even incomprehensible, to other people. Unfortunately, there is substantial evidence that more often than not this is, indeed, the case. It is rare for a description of a treatment to be sufficiently explicit and detailed to enable the treatment to be repeated elsewhere without having recourse to the center of origin for further information.

An earlier ICRU report (ICRU, 1973) described the measurement of absorbed dose in a phantom irradiated by a single beam of X or gamma rays. A second ICRU report (ICRU, 1976) described the determination of absorbed dose in a patient irradiated by beams of X or gamma rays in radiotherapy procedures, and defined a number of terms of importance in these procedures. The present report is the third in a series dealing with dosimetric problems in radiotherapy. Its purpose is to define important volumes, areas and absorbed dose patterns and to recommend methods for specifying the absorbed dose in reports of treatments with external radiation beams. It is hoped, therefore, that this report will be regarded as a step—albeit a very important step—towards the achievement of adequate reports of radiation treatment.

In principle, reports of radiotherapeutic procedures should be as complete as possible and should contain adequate and explicit information on the patient and his disease, the physical parameters and irradiation technique, the overall treatment time and the fractionation scheme. The results of treatment can be meaningfully interpreted only if all these factors can be correlated; in particular only if the parameters of the irradiation, including the distribution of absorbed dose in space and time, can be significantly correlated with the clinical and pathological extent of the disease. Up to now such correlation has been very difficult to establish, because data relating to both the extent of the disease and to the absorbed dose distribution (corrected for the individual patient anatomy) have been inadequate. It is expected that the rapid development of new techniques for the acquisition of patient data, such as computed tomography and ultrasonography, will greatly improve this situation.

While a complete description of the data relating to each patient, as just indicated, is clearly desirable, in practice the amount of information that can be reported in many situations, e.g. in a published paper, is limited. Furthermore, complete information for each patient, including evaluation of the extent of the disease and a full individual dose distribution, is not always available. One is therefore faced with the problem of selecting a minimum of information for reporting; such information will be the most relevant for assessing the results of treatment.

The need for selecting is highlighted by the growing use of computers for recording patient data and treatment procedures. The information recorded in these

systems is usually restricted, but the data should be valid and unequivocal. A subsidiary purpose of the present report, in addition to the specification of treatment volumes and absorbed doses, is therefore to make recommendations on the minimum requirements for reporting external beam therapy. These recommendations are intended to be applicable to most clinical situations, past or present, and to most radiotherapy centers. In some situations factors additional to those listed may be considered to have clinical implications and should therefore be reported as well.

The preliminary drafts of this report were widely circulated among radiotherapists and radiation physicists in several countries, but it will be no surprise that it has not been possible to reach a complete consensus of opinion. Any individual radiotherapist may well find that the recommendations in this report do not conform exactly with his present system of recording. Nevertheless, there are substantial advantages in adopting a common method of reporting. A statement in any individual report that the system used conforms to the recommendations of this report will remove the need for a definition of terms and a detailed explanation of the meaning of statements relating to the absorbed dose and other factors. At the very least, a comparison of any existing system of reporting with that recommended here may help to reveal inadequacies in the local procedures. It is hoped that this report will encourage radiotherapy centers to review their treatment reporting systems and that, in doing so, they will give careful consideration to adopting the present recommendations.

2. Definitions of Terms and Concepts Currently Used in Radiotherapy

Note: Terms and concepts defined in this report are in addition to those defined in previous ICRU reports (e.g., ICRU Report No. 23 (1973), *Measurement of Absorbed Dose in a Phantom Irradiated by a Single Beam of X or Gamma Rays,* and ICRU Report No. 24 (1976), *Determination of Absorbed Dose in a Patient Irradiated by Beams of X or Gamma Rays in Radiotherapy Procedures).*

2.1 Volumes

2.1.1 Aim of Therapy

A. Curative Treatment of Malignant Disease. In the *curative treatment* of malignant disease anatomic tumor limits may or may not be demonstrated. When demonstrated, the location and extent of the *tumor volume* may be determined by means of clinical examination, roentgenologic, radioisotopic, ultrasonic, and microscopic techniques. When the tumor has been previously removed (e.g., by mastectomy or hysterectomy) the remaining tissues may contain occult disease, the limits of which can not be demonstrated.

When planning treatment the volume to be treated to a curative absorbed dose level has to include not only the demonstrated tumor but also its presumed occult spread.

B. Palliative Treatment of Malignant Disease. The palliative treatment of malignant disease may include all or only part of the demonstrated tumor(s) (e.g., irradiation of the spine for a painful deposit in a case of widespread metastases).

C. Non-malignant Diseases. The radiotherapy of non-malignant conditions may or may not include all of the affected tissues (e.g., irradiation of a painful joint in ankylosing spondylitis).

2.1.2 Target Volume

The *target volume* contains those tissues that are to be irradiated to a specified absorbed dose according to a specified time-dose pattern. For curative treatment the target volume consists of the demonstrated tumor(s), if present, and any other tissue with presumed tumor.

The delineation of the target volume will require such considerations as the local invasive capacity of the tumor and its potential to spread to regional lymph nodes. Consideration needs to be given to the presence of any specially radiosensitive normal tissue (organs at risk) as well as to other factors such as the general condition of the patient.

For any given situation there may be more than one target volume.

Physical treatment planning is dependent on the delineation of the target volume(s) and the prescription of the target absorbed dose. These two factors constitute the medical decision which must *precede* the determination of the dose distribution in the patient. (In the past this sequence has often been reversed and the target volume defined in terms of the dose distribution, for example, the volume enclosed by a particular isodose surface. This procedure is *not* recommended).

The target volume(s) must always be described, independently of the dose distribution, in terms of the patient's anatomy and topography, and the physical dimensions given. When a dose distribution in one or more anatomical sections is presented, the target volume (or area in a particular section) should be clearly indicated on the diagram. If the whole body section constitutes the target volume, this fact should be indicated on the isodose chart and stated in any accompanying description.

The size and shape of a target volume may change during a course of treatment (e.g., shrinkage of a mediastinal lymphoma), necessitating replanning.

Note: For external beam therapy the following parameters should be taken into account when describing the target volume:

a. expected movements (e.g., caused by breathing) of those tissues which contain the target volume relative to anatomic reference points (e.g., skin markings, suprasternal notch),
b. expected variation in shape and size of the target volume during a course of treatment (e.g., urinary bladder, stomach),
c. inaccuracies or variation in treatment set-up during the course of treatment.

An example of target volumes in a patient with a carcinoma of the breast is given in Figure 2.1.

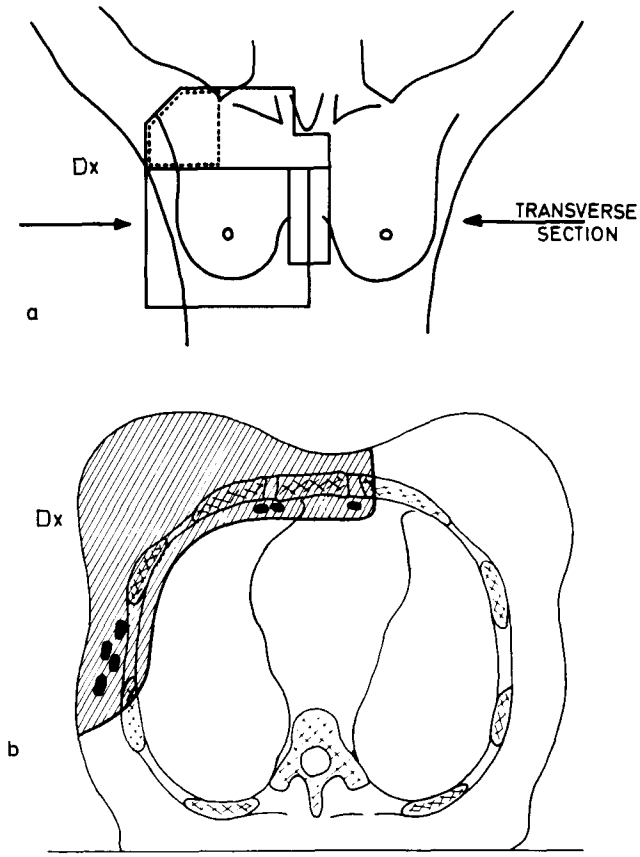


Fig. 2.1. Radiotherapy for cancer of the breast as a sole method of treatment, or combined with surgery. Example of a target volume which includes not only the breast (in unoperated patients) and the chest wall but also the internal mammary, the supraclavicular, and the axillary lymph nodes. The target volume appears as a target area (shaded area) in the transverse section (b). In practice, as shown in (a) several target volumes have to be identified, which are irradiated with different beams, which partly overlap (From Abbatucci *et al.*, 1972.)

2.1.3 Treatment Volume

Because of limitations in treatment techniques it is impossible to administer the prescribed absorbed dose exclusively to the target volume. In general the volume receiving at least the same absorbed dose as any part of the target volume can not be made to coincide with the target volume but will be larger and often of a simpler shape.

The *treatment volume* is the volume enclosed by an isodose surface, the value of which is the minimum target absorbed dose (see Section 2.2.3). In some cases the treatment volume may be considerably larger than the target volume, as shown in Figure 3.2.

2.1.4 Irradiated Volume

The *irradiated volume* is that volume, larger than the treatment volume, which receives an absorbed dose which is considered significant in relation to tissue tolerance. The significant absorbed dose level can be expressed as absorbed dose in percentage (e.g. 50%) of the specified target absorbed dose (see below) (e.g., Figure 3.5).

The irradiated volume, as well as the treatment volume, will depend on the treatment technique used.

2.1.5 Organs at Risk

Organs at risk are specially radiosensitive organs in or near the target volume whose presence influence treatment planning and/or prescribed dose.

2.2 Absorbed Dose Pattern

2.2.1 Representation of a Spatial Dose Distribution by a Set of Planar Dose Distributions

A uniform dose distribution can rarely be achieved in a target volume, and it is necessary to evaluate the spatial absorbed dose distribution.

Such an evaluation could be made, in principle, by considering the dose distribution in a set of parallel planar sections sufficiently close to each other (the distance between two sections being equal to the distance between the "lattice points", see Section 2.2.4).

However, for practical reasons only a limited number of sections can be evaluated. These sections may be selected in the following way (Figure 2.2). The part of the patient containing the target volume and relevant anatomic structures is considered as a stack of several parallel slices, the thickness of the slices being chosen so that in each slice the following conditions are fulfilled:

a. no important variations occur in the external contour,
b. no important variations occur in the topography of the relevant internal structures: size, shape and location of the target volume, organs at risk, heterogeneities, etc.,
c. no important variations are expected in the dose distribution that are relevant to the treatment plan.

For each slice a section is chosen on which the extreme borders of the target volume, the organs at risk, the tissue heterogeneities and the reference points in that slice are projected perpendicularly. The section then displays all the relevant structures and the part of the target volume which is located within this slice now appears as a target area.

In many simple situations consideration is given only to one section, as illustrated in Figure 2.3 for a patient with a carcinoma of the urinary bladder.

The following definitions (Sections 2.2.2–2.2.7) apply to dose calculations in a section. They are clinically relevant only if they can be assumed to represent the corresponding spatial situation.

2.2.2 Maximum Target Absorbed Dose ($D_{T,max}$)

The *maximum target absorbed dose* is the highest absorbed dose in the target area that can be regarded as "clinically meaningful". The latter term implies that at least a minimum area is irradiated to the dose level designated as "maximum". The minimum area recommended for this purpose is 2 cm^2, unless the whole target area is less than 4 cm^2, in which case a minimum area of 1 cm^2 should be taken to define the maximum target absorbed dose.

The value 2 cm^2 is based on two considerations. First, 2 cm^2 represents approximately the smallest area for which the absorbed dose can be calculated with confidence, either manually or with a computer; second, the maximum target absorbed dose is often related to the limiting effects of treatment such as tissue tolerance and the smallest volume of tissue to which these effects apply is considered to be that volume whose section is at least 2 cm^2.

Within an isodose curve enclosing an area of 2 cm^2 the dose at a point may be even higher, but it is recommended that such hot points be ignored in designating the value of the maximum target absorbed dose.

2.2.3 Minimum Target Absorbed Dose ($D_{T,min}$)

The *minimum target absorbed dose* is the lowest absorbed dose in the target area. No area limit is recommended when reporting minimum target absorbed dose.

2.2.4 Mean Target Absorbed Dose ($D_{T,mean}$)

For the determination of the mean, as well as of the median and modal target absorbed dose, it is necessary to calculate the dose at each of a large number of discrete points (lattice points), uniformly distributed in the target area.

The *mean target absorbed dose* is then calculated as the mean of the absorbed dose values in these lattice points and can be expressed by the equation:

$$D_{T,mean} = \frac{1}{N} \sum_{A_T} D_{i,j}$$

where N is the number of lattice points, i is the column index in this lattice, j is the row index, and $D_{i,j}$ is the absorbed dose at the lattice point i,j located inside the target area A_T.

2.2.5 Median Target Absorbed Dose ($D_{T,median}$)

The *median target absorbed dose* is the central value among the set of values of the absorbed dose at all lattice points in the target area, when arranged according to magnitude.

2.2.6 Modal Target Absorbed Dose ($D_{T,modal}$)

The *modal target absorbed dose* is the absorbed dose that occurs most frequently at lattice points in the target area. Its value may be influenced by the choice of method for its calculation (e.g., spacing of lattice points). Exceptionally, in a particular patient, more than one modal target absorbed dose may be found.

An example of a computerized calculation of the different above-mentioned target absorbed doses in one section of a patient is given in Figure 2.4.

2.2.7 Hot Spots

In many situations tissues *outside the target area* will receive a relatively high absorbed dose. A *hot spot* is an area which receives an absorbed dose higher than 100% of the specified target absorbed dose (see Section 3.3). However, as in the case of the maximum target absorbed dose (see Section 2.2.2), a hot spot is considered clinically meaningful only if the corresponding isodose curve encloses an area of at least 2 cm^2 in a section.

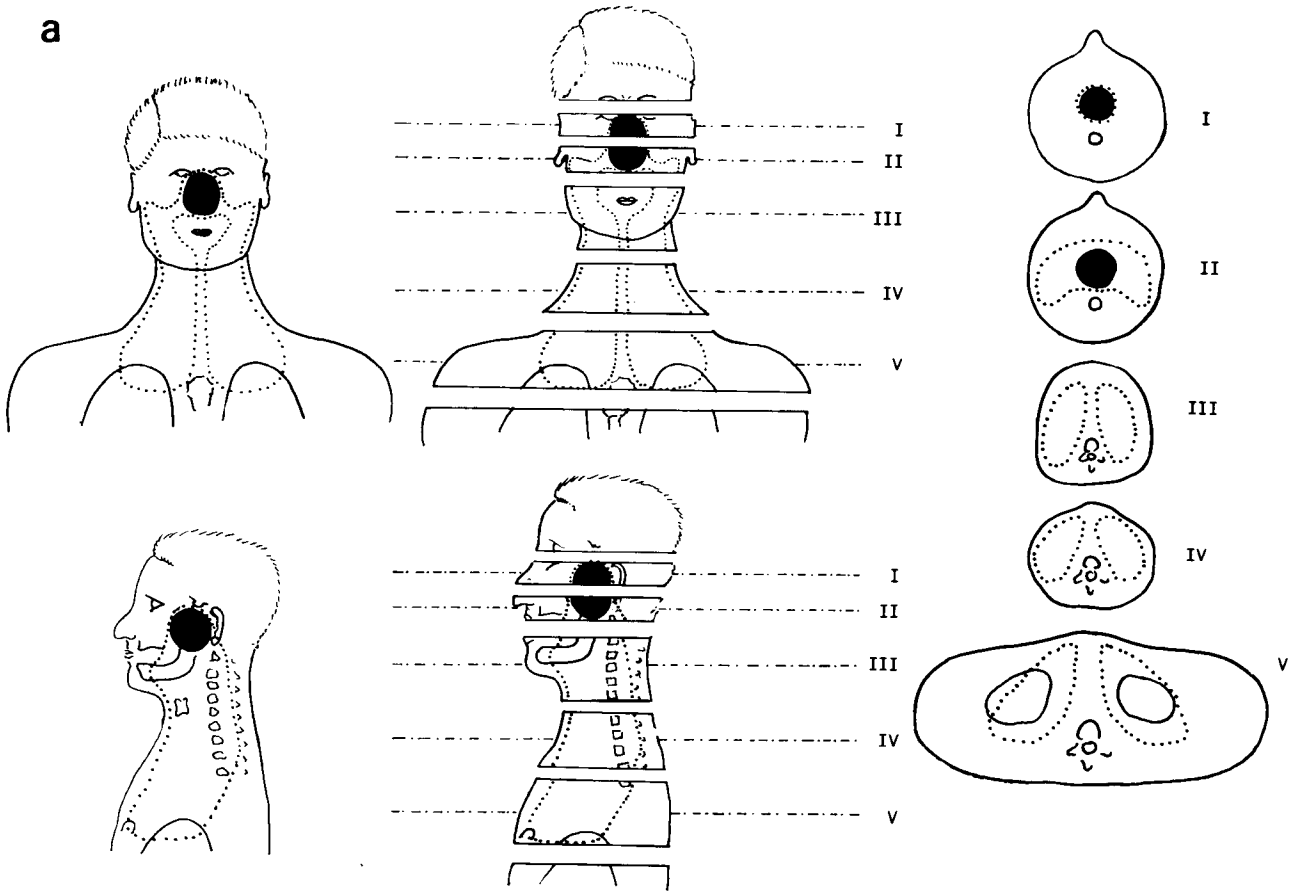
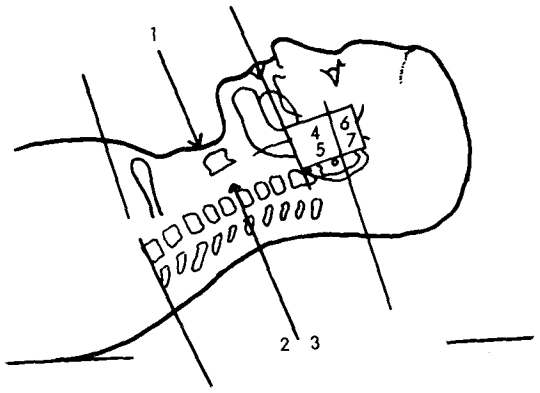
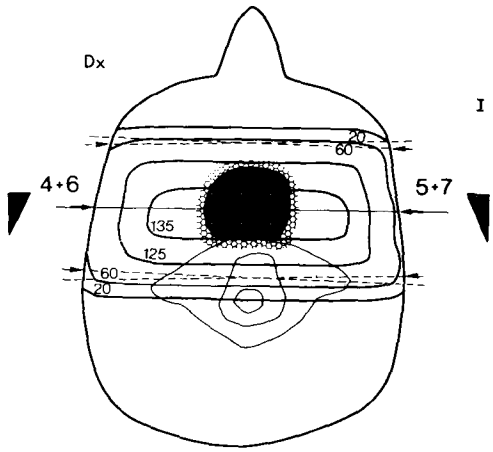


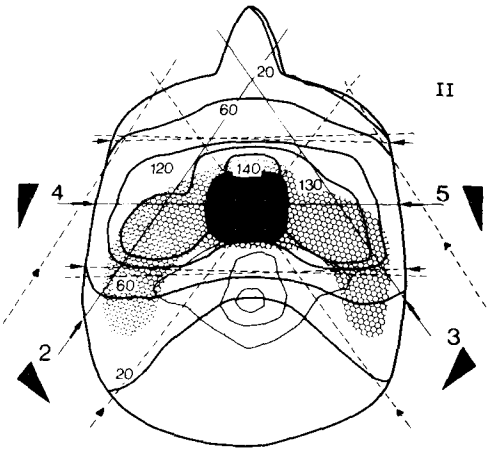
Fig. 2.2(a). Example of a multi-section dose plan for the curative treatment of a carcinoma of the nasopharynx (demonstrated tumor = target A, indicated by black) and its presumed spread to the regional lymph nodes in the neck and supraclavicular fossae (subclinical disease = target B, indicated by the dotted line (Figure 2.2(a)) or honeycombed area (Figure 2.2(b), page 7). The prescribed absorbed dose for target A is higher than that for target B. The organs at risk are the spinal cord, brain stem, and to some extent the eyes. When calculating the absorbed dose distribution, correction for tissue heterogeneity (lung tissue and bone) may be applied. The preliminary suggestion for treatment technique is a multifield arrangement with lateral fields towards target A and one anterior and two oblique posterior fields towards target B, in order to keep the dose to organs at risk as low as possible. After having defined optimal patient positioning with respect to suggested treatment technique, representative sections will be produced. In this case, 5 sections (I–V) were needed for the calculation of the absorbed dose pattern because of variation in shape and size of the two target volumes, outline of the patient and treatment technique. Each section represents one slice of the patient. The extreme borders of the target volume, organs at risk, tissue heterogeneities and reference points in that slice have been projected perpendicularly on to the section, thus defining the target area and other relevant structures in the section.

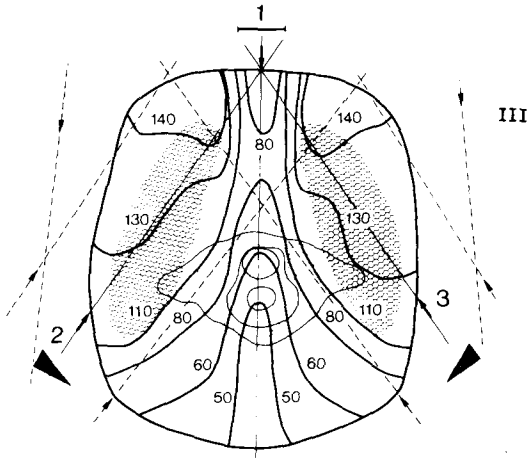
Fig. 2.2(b). (Opposite page) The accepted dose plan appears in b. The schematic figure (top left) indicates (Arabic numerals) arrangement of the fields. (Note: beams 2, 4, and 6 are actually directed towards the right side of the patient.) The weighting of the beams and the absorbed dose distribution in each of the five sections have been normalized to peak absorbed dose in beam 1 (Modified from: Landberg and Svahn-Tapper, 1976.)

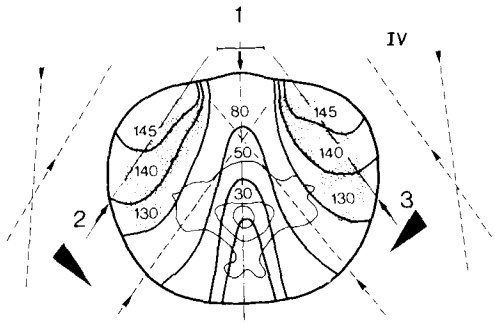
b

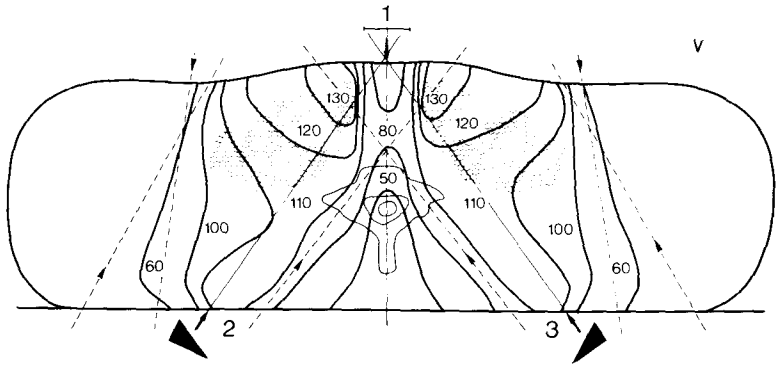












Field	Radiation	SSD *cm*	Field size *cm* x *cm*	Weight %	Wedge	Compensator
1	^{60}Co *gamma rays*	70	20 x 15	100	-	60 cm lead centrally
2,3	^{60}Co *gamma rays*	70	8 x 18	50	45°	-
4,5	8 MV X-*rays*	100	5 x 6	50	15°	-
6,7	8 MV X-*rays*	100	5 x 3	30	-	-

5 cm

	Absorbed dose (per cent of peak absorbed dose in beam 1)		
	Target A	Target B	Brain stem, spinal cord
	Max.-Min.	Max.-Min.	Max.
Section I	135-125	-	55
II	140-120	140- 40	40
III	-	140-110	55
IV	-	145-130	40
V	-	130-100	45

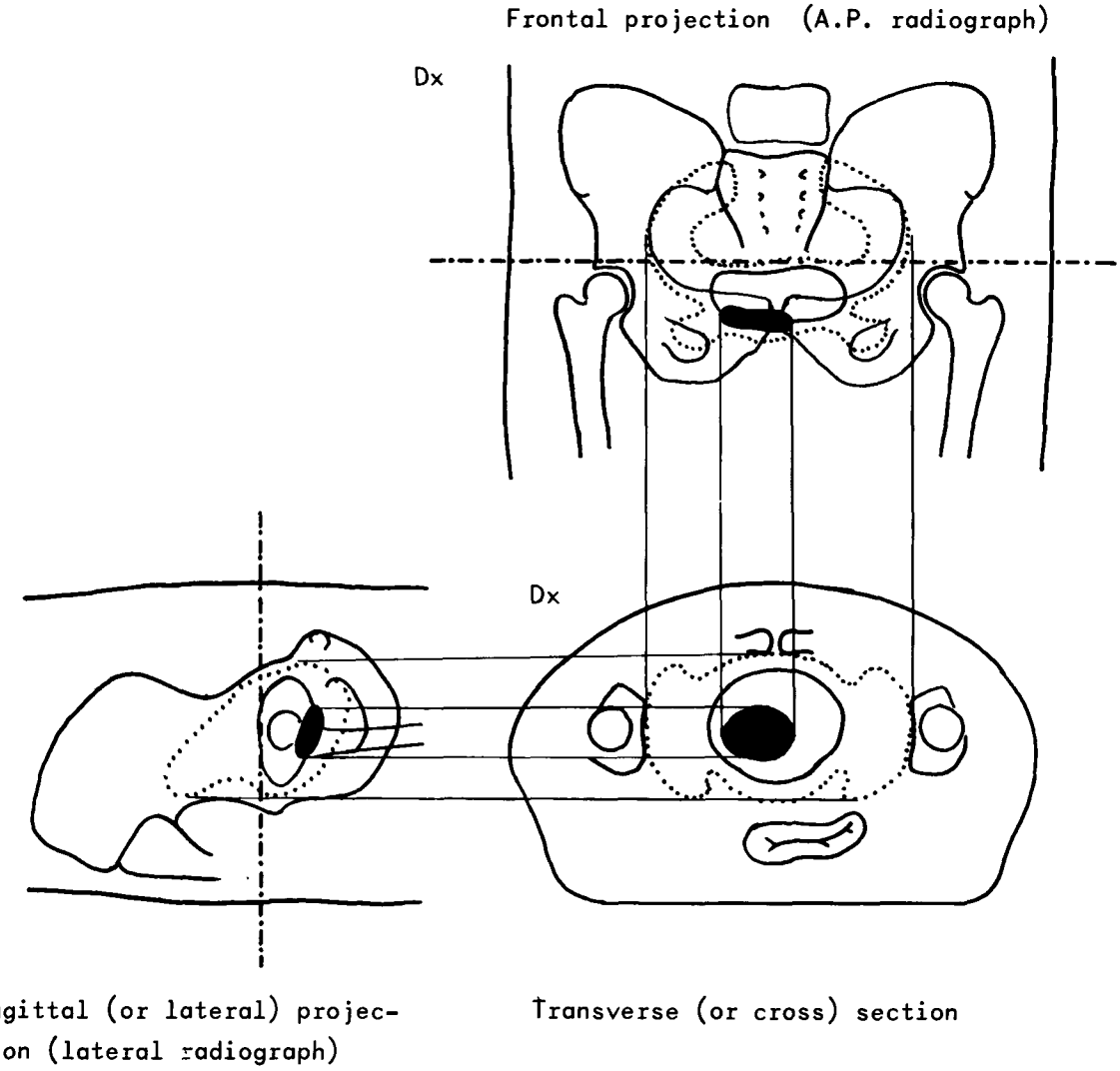
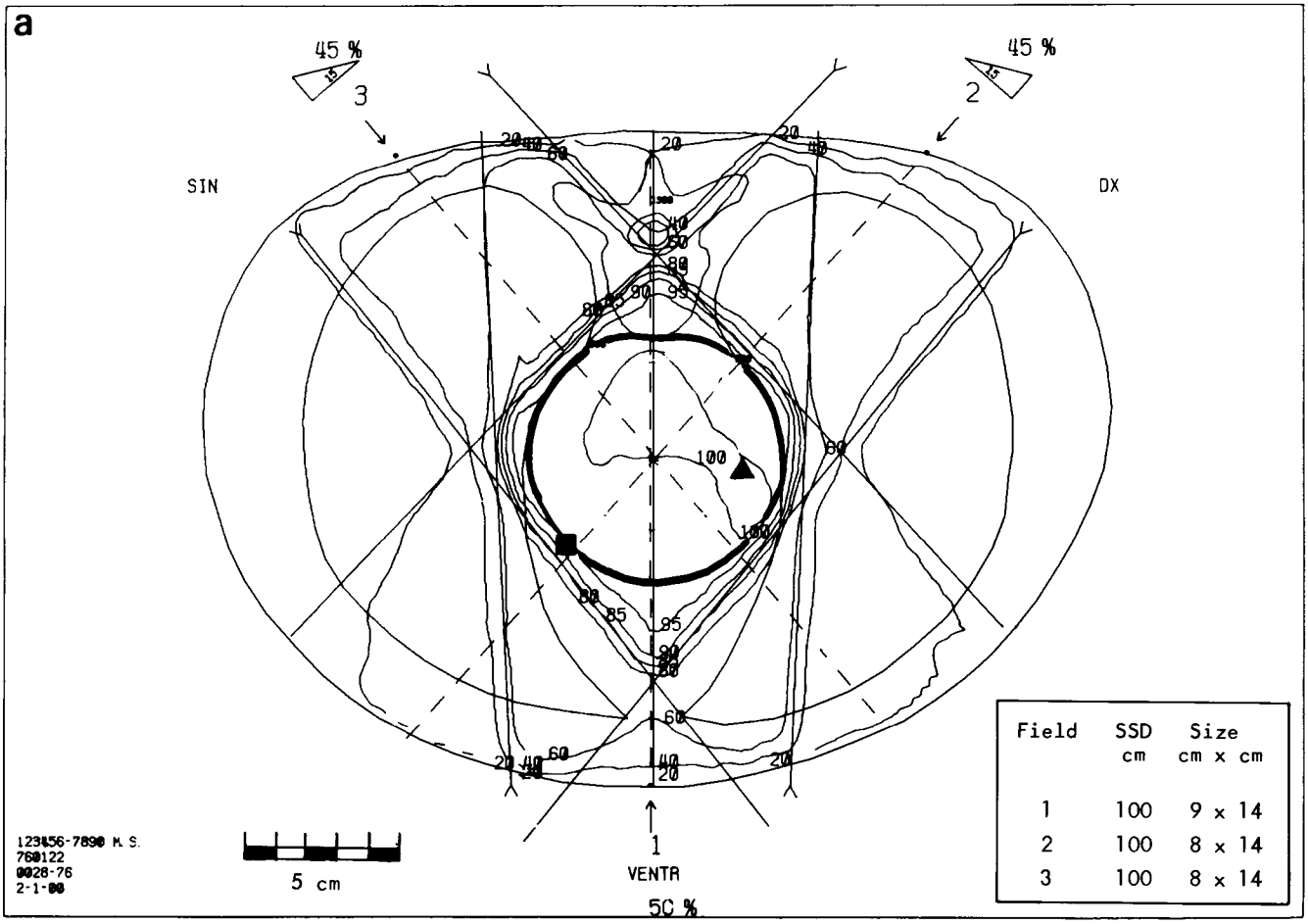


Fig. 2.3. Example of a target in a patient with localized cancer of the urinary bladder and presumed occult spread. The transverse section is considered to be representative of the whole target volume and the relevant normal tissues. For the graphical construction of the transverse section two radiographs are used that represent two perpendicular projections of the anatomy of interest. The border of the target is indicated by the dotted line. The target appears in the two radiographs and is indicated as an area in the section. It includes the demonstrated tumor (indicated in black), the whole bladder and the regional lymph nodes (the iliac and the obturator groups) as well as connecting lymphatics.

Fig. 2.4(a). (Opposite page) Computerized calculation of the absorbed dose distribution (8 MV x rays) for a patient with carcinoma of the esophagus, treated only in the prone position. (a) Transverse section of the patient. The calculation of the absorbed dose includes correction for tissue heterogeneity, the "effective density" of the lung tissue being considered to be 500 kg m^{-3} and that of bone to be 1300 kg m^{-3}. The border of the target area is indicated by the thick line.
The display gives the distribution of the absorbed dose and also the position of the maximum (▲) and the minimum (■) target absorbed dose. In this special case, the weighting of the beams (peak absorbed dose 50%, 45%, and 45%, respectively), was chosen to give an absorbed dose of 100% at the point of intersection of the central axes of the three beams.

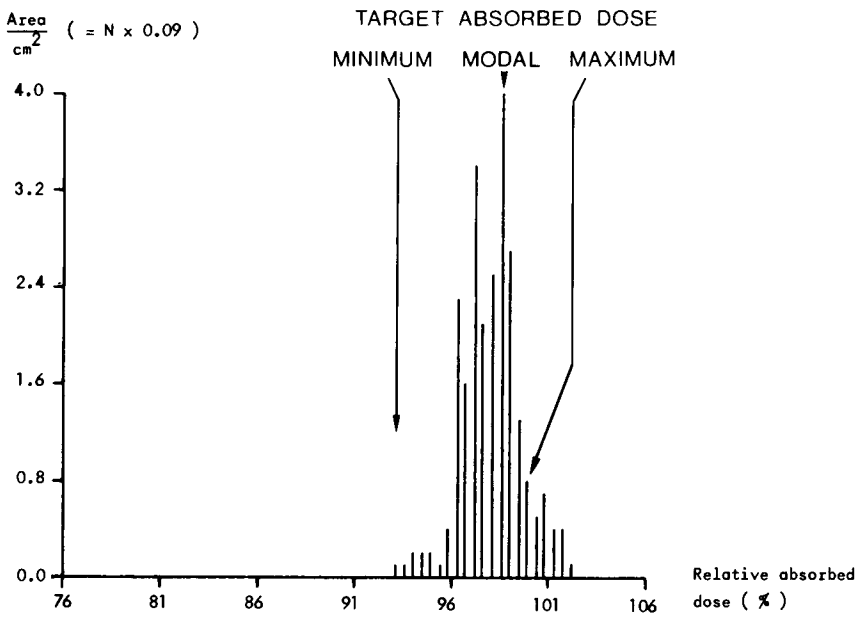
Fig. 2.4(b). (Opposite page) For the same patient a histogram is given to demonstrate the distribution of absorbed dose in the target area. The computation of the histogram gives sizes of areas (one lattice point representing an area of 3 mm × 3 mm = 0.09 cm^2) for 21 equally large intervals of absorbed dose percentage values, ranging from 102% to 93%. The maximum target absorbed dose considered to be meaningful and to be used for reporting (see Section 2.2.2) is 100%. The modal target absorbed dose is 99%, and the median 98%. The computation also gives the mean target absorbed dose (98%) (Modified from: Möller *et al.*, 1976.)

a



Field	SSD cm	Size cm x cm
1	100	9 x 14
2	100	8 x 14
3	100	8 x 14

b



3. Recommendations for Reporting Absorbed Doses in External Beam Therapy

3.1 Introduction

The absorbed dose distribution is usually not uniform in the target volume (see Section 2.2.1). However, for the purpose of treatment reporting a nominal absorbed dose, which will be called *target absorbed dose*, has to be selected. The use of the expression "tumor dose" is no longer recommended.

The maximum and minimum target absorbed doses alone or together can not as a rule be used for reporting since they are not always representative of the dose distribution. Although local tumor control depends on the minimum dose to the malignant cell population, the use of the minimum target absorbed dose alone can not be recommended, since difficulties in determining the extent of the malignancy may reduce its clinical significance and further may lead to ambiguity in its definition.

The mean, median and modal target absorbed doses can not be generally recommended since they usually require a complete computerized dose plan, which may be available only for a limited number of patients and/or hospitals.

The absorbed dose selected for reporting should be chosen to be representative of the dose distribution in the target volume, and its calculation should, if possible, not necessitate special computation facilities.

It should be stressed that target absorbed dose, as specified in the following paragraphs, represents a minimum requirement for reporting, often carrying limited radiobiological and clinical information.

Finally, the specification of target absorbed dose for reporting depends on the treatment technique, and its significance can only be interpreted when information on the irradiation technique has been given.

3.2 Description of Technique

Necessary information:

a. Radiation quality
   1. for conventional (100-300 kV) or low energy (< 100 kV) x rays, the accelerating potential (kV) and HVL,
   2. for gamma rays, the radionuclide (element and mass number),
   3. for high energy x rays, the equivalent accelerating potential (MV) and the type of machine,
   4. for electron beams, the energy (MeV) and type of machine.

b. The number and arrangement of the beams. Indication of SSD or SAD. The description of the beam arrangement of external beam therapy should always be done in relation to the patient.

c. Field sizes: geometrical field sizes which usually correspond to the 50% isodose curve. For fixed SSD, the field sizes are usually given at the skin; for fixed SAD (isocentric arrangement) the field sizes are given at the isocenter. For any field, its size in the planned section should be given first.

d. Beam modification devices (wedges, shielding blocks, etc.).

e. Beam weighting. State whether this is defined in terms of the ratio of peak (applied) absorbed doses for the single beams, or in terms of the ratio of doses delivered at a defined point in the target, such as the isocenter or the "specification point" (see Section 3.3.4). To avoid ambiguity, the meaning of beam weighting should always be made clear.

f. Corrections for tissue heterogeneity (state whether performed or not).

g. Patient positioning.

Optional information:

h. Absorbed dose distribution (isodose pattern).

i. "In vivo" absorbed dose measurements.