Radiation Therapy Definitions and Reporting Guidelines for Thymic Malignancies

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The role of radiation therapy in the treatment of thymic malignancies is still being established, and many details that have never been clearly defined are currently being critically examined. Such an assessment has been hampered by significant inconsistency in how radiotherapy (RT) is delivered, how the RT field is defined, which patients are selected for treatment, and how outcomes are reported. An opportunity to change this has arisen through the development of the International Thymic Malignancy Interest Group (ITMIG), which is an organized collaboration of individuals interested in this field. The prerequisite to progress, however, is to establish definitions and consistent policies, so that results can be understood and compared. This is the topic addressed in this article.

METHODS

A workgroup was assembled to review literature relevant to the issues and formulate preliminary recommendations (Daniel Gomez, Ritsuko Komaki, James Yu, Hitoshi Ikushima, and Andrea Bezjak). These were refined by an extended workgroup (Charles Thomas, Lynn Wilson, Gregory Videtic. James Metz, Harun Badakhshi, Clifton Fuller, Francoise Mornex, Conrad Falkson, David Ball, and Ken Rosenzweig) and discussed further in a broad ITMIG multidisciplinary workshop meeting, which was supported by the International Association for the Study of Lung Cancer. A draft of this article, containing the proposed policies and standard operating procedures, was then disseminated to all ITMIG members for further discussion. The final version of this article was then written, taking all the input into consideration, and was ultimately approved by the ITMIG members for use in ITMIG collaborative initiatives.

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BASIC DEFINITIONS

Clinical Setting and Treatment Intent

The mainstay of treatment of thymomas and other thymic malignancies is surgery. RT is predominantly used after surgery, to reduce the risk of mediastinal relapse. However, it can be used in other clinical scenarios as well, such as part of definitive treatment for patients that are not medically operable or for tumors that are not resectable after a regimen of preoperative chemotherapy. As most patients have disease confined to the thorax, RT fields often encompass one or more thoracic structures (mediastinum, pleura, and occasionally pericardium) and typically with the aim of local control and tumor eradication. However, in the setting of recurrent disease, the doses and intent may vary, e.g., lower doses mainly aimed at symptom improvement, rather than disease eradication, may be employed. Thus, a clear statement of the clinical context (setting), aim, and area treated with radiation is needed, so that reports can be more meaningfully compared to determine the outcomes after radiotherapy and advance the treatment of thymic malignancies. The following definitions are proposed, as summarized in Table 1.

Clinical context (setting)

- Preoperative, i.e., before surgery—RT or chemotherapy alone may be administered or a regimen of concurrent or sequential chemotherapy and RT may be used.
- Postoperative, i.e., after surgery—treating oncologists and authors of publications should indicate whether postoperative RT is being given in setting of complete resection (R0), microscopic residual disease (R1), or gross residual disease (R2), as RT doses used may vary. If both postoperative radiation and postoperative chemotherapy are administered, that should be indicated as well, as it may affect both toxicity and outcomes. Postoperative RT may be given to part or all the mediastinum, pericardium, hemithorax, or to portions of the pleura if resection of pleural metastases was performed.
- Definitive RT (alone or combined with chemotherapy)—if there are no plans for surgery, RT alone or chemoradia-

TABLE 1. Summary of Reporting Guidelines and Data Fields for Thymic Malignancies Treated with Radiation Therapy

Reporting Category	Data Fields
Intent	Palliative
	Preoperative (downstaging or downsizing)
	Curative
	Sole modality
	With concurrent or sequential chemotherapy
	Postoperative
	Postoperative R0 resection
	Postoperative R1 resection
	Postoperative R2 resection
Radiation field (report all that apply)	Gross tumor with margin
	Tumor bed with margin
	Elective sites beyond initially involved area (i.e., mediastinum and lymph nodes)
	Sites of pleural metastases
	Hemithorax
Radiation dose	Date initiated and date completed
	Radiation dose, initial volume (Gy)
	Radiation fraction size, initial volume (Gy)
	Boost given: yes/no
	Boost timing: sequential/concurrent
	Boost dose (Gy)
	Boost fraction size (Gy)
Radiation technique	2D planning
	3D conformal therapy
	IMRT
	Proton therapy
	Other
Local recurrence after radiation	In field
	Marginal recurrence
	Out-of-field
Radiation toxicity (use Common Toxicity Criteria for Adverse Events v4.0, report all that apply)	Grades 3–5: Esophagitis/cardiac/respiratory/other
	Maximal toxicity grade (3–5)
	Toxicity duration
	Dose-limiting toxicity: yes/no

IMRT, intensity modulated radiation therapy.

tion is being used as primary treatment of the thymic malignancy.
- RT for recurrent disease—area of recurrence needs to be specified, as well as the type of RT (external beam, endobronchial brachytherapy, and intraoperative).

Aims

- Curative—with the intent to definitively treat the disease, e.g., for long-term disease control.
- Palliative—with the aim of symptom improvement and/or reduction in tumor size but not eradication of tumor being irradiated.

Area treated

- Gross tumor with margin (primary tumor or lymph nodes).
- Tumor bed with margin (as delineated by preoperative and postoperative imaging and surgical findings, including surgical clips).
- Elective sites beyond initially involved area (mediastinum and lymph nodes).
- Sites of pleural metastases (either in postoperative setting, after resection, or in a curative or palliative setting, e.g., pleural effusion or pleural implants).
- Entire hemithorax (right or left).

Outcome Assessments of Particular Relevance to RT

The article "Standard Outcome Measures for Thymic Malignancies" provides specific definitions of appropriate survival measures and which patients should be included in the reporting of specific events, as well as definition of recurrences (time, and whether local, regional, or distant) and a discussion on how to measure and assess response to treatment (chemotherapy and radiation).[1] Briefly, local recurrence is defined as disease appearing in the bed of the thymus, regional recurrence is intrathoracic tumor that is not "immediately contiguous with the thymus gland or previous thymic neoplasm," and distant recurrence is disease outside of this region, to include intrapulmonary nodules. Future studies should be specific and report outcomes according to these definitions. Of specific interest with respect to RT is whether a local or regional recurrence occurring after postoperative RT is within, at the margin of, or outside the RT field (defined by the relationship to the beam edge). This specification is of particular interest in the modern era, as treatment planning has shifted from wide-field two-dimensional planning (covering large areas of mediastinum) to more conformal three-dimensional (3D) planning with a reduction of the area treated to tumor bed and/or anterior mediastinum—this shift has the potential of increasing marginal and out of field failures. Careful and detailed reporting of recurrences and their relationship to the RT fields and pooling of the data are required to ascertain that changes in RT techniques are not adversely affecting the outcomes of patients with thymic malignancies.

RADIATION TECHNIQUES

Patient Positioning and Simulation

Patients should be strictly immobilized, preferably in a supine position with the neck slightly extended and with their arms over their head, if possible. This position will allow for multifield planning techniques using oblique coplanar and/or noncoplanar beam angles. A computed tomography (CT) simulation should be performed, with 3- to 5-mm slices. Intravenous contrast may be considered to better differentiate the target and normal structures. When available, a four-dimensional (4D) CT scan should be performed, to assess for internal motion during treatment planning.[2] If no 4D CT scan is available, the treating radiation oncologist can consider the following to assess the magnitude of internal motion: (1) a slow helical 4D CT scan that acquires images during the entire breathing cycle and (2) CT images at full inspiratory and expiratory phases, with the difference being estimated as

the magnitude of movement during breathing. A fusion of the treatment planning CT scan with a fluorodeoxyglucose-positron emission tomography scan can serve as a useful adjunct in the treatment planning process.[3]

The following target volumes should be reported:

- Gross tumor volume (GTV), if present—gross disease.
- Clinical target volume (CTV)—GTV plus microscopic spread or area thought to be at risk for microscopic spread. Historically, the CTV has covered the whole mediastinum, to also include the preoperative extent of disease. Nevertheless, with the availability of more precise imaging, including the widespread use of CT simulation, a more limited CTV is generally more appropriate, to encompass the postoperative region at risk as indicated by preoperative imaging and intraoperative findings, including the placement of surgical clips to indicate regions at particular risk for persistent disease. Treating physicians should specify if they are treating the involved sites (gross tumor or tumor bed) with a margin or elective sites beyond the initially involved area, such as the lymph nodes or the mediastinum.
- Internal target volume (ITV)—CTV plus internal motion.
- Planning target volume (PTV)—ITV plus patient setup error.

In the postoperative setting, target volumes should be delineated using a combination of the patient's preoperative and postoperative imaging. The preoperative imaging should be assessed to determine the initial extent of disease.

Target margins are dependent on the techniques used during simulation and treatment planning, such as a 4D CT simulation and daily kV imaging. If these modalities are not available, then larger margins could be considered, depending on the location of the tumor (with more inferior tumors expected to move more) and the treating physician's confidence in daily setup. Acceptable margins are as follows:

- GTV to CTV margin: 0.5 to 1.0 cm.
- CTV to PTV margin, without 4D CT simulation (or equivalent) and without daily kV imaging: 1.0 to 1.5 cm.
- ITV to PTV margin, with 4D CT simulation (or equivalent) but without daily kV imaging: 0.5 to 1.0 cm.
- ITV to PTV margin, with 4D CT simulation and daily kV imaging: 0.5 cm.

A joint ITMIG radiologist/radiation oncologist task force is developing a consensus atlas for cancers of the thymus, to include contour delineation recommendations.

Radiation Treatment Planning

Historically, RT for thymoma has been delivered with two-dimensional techniques and simple field arrangements such as opposed lateral fields. Nevertheless, given the advances in radiation technology in the past several years, conformal techniques are highly recommended if available to spare the surrounding mediastinal structures. These techniques include 3D conformal radiation and intensity modulated RT (IMRT).

"3D conformal radiation" is defined as the use of multiple beams and the creation of a dose volume histogram to evaluate the dose delivered to the tumor and normal structures (specifically, doses to at least the following structures: esophagus, heart, lungs, and the spinal cord). "Intensity modulated radiation therapy" (IMRT) is defined as treatment through the arrangement of multiple beams, similar to 3D conformal planning, with the addition of the capability to alter the fluence of the radiation beam during treatment delivery and that of inverse planning (the ability to specify constraints to various structures before beam arrangement). If IMRT is available, then this technique offers the advantage of improved conformality over 3D conformal treatment. The improvement in therapeutic ratio of IMRT over 3D conformal therapy has been shown in several dosimetric studies in lung cancer and in a recent clinical study assessing survival and toxicity endpoints in 3D conformal RT versus IMRT in this disease.[4] Although there has never been a direct comparison in the setting of thymoma, the advantages of conformality could be expected to be extrapolated in this malignancy as well, which is located in the mediastinum as well, near the same critical structures. If IMRT is used, then the American Society for Therapeutic Radiation Oncology guidelines (http://www.astro.org/Research/ResearchHighlights/documents/IMRT.pdf) can and should be used by the treating physician to optimize treatment planning, as reinforced by the National Cancer Comprehensive Network guidelines for the treatment of thymic malignancies (www.nccn.org). The radiation technique should be described as outlined in Table 1, in the category radiation technique.

Dosimetric Parameters for Thymoma

Table 2 outlines appropriate dosimetric parameters on normal structures to be used in the setting of thymoma, adapted from the most recent Quantitative Analysis of Normal Tissue Effects in the Clinic guidelines and applicable to all sites of thoracic RT.[5] The total elapsed days of treatment, fraction size, energy, treatment field configuration, total dose, and dose volume histogram parameters should be clearly described.

POSTOPERATIVE RADIATION FOR THYMOMA

Postoperative RT After Completely Resected Thymoma (R0)

Postoperative radiation is typically administered within 3 months after surgery. If initial postoperative imaging indicates no residual disease and radiation is not initially recommended but subsequently on later imaging the tumor recurs and becomes grossly visible, then radiation given at this point is for "recurrent" disease, the intent of radiation is no longer "postoperative." The treatment should be documented, both clinically and for the purposes of publication, as "radiation for recurrent disease." We propose that the minimum postoperative dose that can be counted as adjuvant RT for thymoma after surgery is 40 Gy, in 1.8 to 2 Gy fractions, even when no residual disease remains. The dose, regardless of setting, should be reported as described in Table 1 in radiation dose and include date initiated, date completed, total

TABLE 2. Dosimetric Constraints to be Used and Reported in the Treatment of Thymic Malignancies[5]

	RT Alone	Chemotherapy and RT	Chemotherapy and RT Before Surgery
Spinal cord[a]	D_{max} <45 Gy	D_{max} <45 Gy	D_{max} <45 Gy
Lung[b]	MLD ≤20 Gy	MLD ≤20 Gy	MLD ≤20 Gy
	V_{20} ≤40%	V_{20} ≤35%	V_{20} ≤30%
		V_{10} ≤45%	V_{10} ≤40%
		V_5 ≤65%	V_5 ≤55%
Heart	V_{30} ≤45%	V_{30} ≤45%	V_{30} ≤45%
	Mean dose <26 Gy	Mean dose <26 Gy	Mean dose <26 Gy
Esophagus	D_{max} ≤80 Gy	D_{max} ≤80 Gy	D_{max} ≤80 Gy
	V_{70} <20%	V_{70} <20%	V_{70} <20%
	V_{50} <50%	V_{50} <40%	V_{50} <40%
	Mean dose <34 Gy	Mean dose <34 Gy	Mean dose <34 Gy
Kidney[c]	20 Gy <32% of bilateral kidney	20 Gy <32% of bilateral kidney	20 Gy <32% of bilateral kidney
Liver	V30 ≤40%	V30 ≤40%	V30 ≤40%
	Mean dose <30 Gy	Mean dose <30 Gy	Mean dose <30 Gy

[a] The size of the treated volume of the spinal cord should be considered, as the chance of spinal cord damage increases with increasing treated volume. When PTV is close (<1 cm) to spinal cord such as vertebral invasion, the spinal cord may receive a dose higher than recommended dose threshold to keep adequate dose to target volume particularly GTV. Nevertheless, the spinal cord should not receive more than 60 Gy, even in a very limited volume. A higher fraction size or a higher daily dose reduces tolerance. If treatment is given in 3 Gy fractions, the constrained dose to the cord should be approximately 40 Gy.

[b] V_{20} = the effective lung volume (total lung volume − gross tumor volume) receiving 20 Gy or more. For patients who undergo pneumonectomy before RT, we recommend an MLD of <8 Gy, a V_{20} of <10%, and V_5 <60%. Note that in the setting of postoperative treatment in which a gross total resection has been achieved, there is no GTV, so the lung constraint will be representative of solely the total lung, not the total lung minus the CTV.

[c] Consider a kidney scan if a large volume of one kidney will be treated with a high dose.

RT, radiotherapy; MLD, mean lung dose; D_{max}, maximal dose; PTV, planning target volume; CTV, clinical target volume; GTV, gross tumor volume.

dose, fraction size, dose to initial field, and dose to boost field. Doses for "hemithoracic" fields are a separate issue distinct from the treatment of the surgical bed and are discussed later. When the tumor has been completely resected, minimum fields for postoperative radiation should encompass the preoperative extent of disease, as indicated by preoperative imaging and regions of risk identified intraoperatively. If no other areas are treated, this field should be reported as "tumor bed with margin." If elective sites are treated, including the entire mediastinum or elective lymph nodes, the field should be reported as "elective sites beyond initially involved area" (as summarized in Table 1, radiation field). If lymph nodes are biopsy proven to be grossly involved with disease, nodal irradiation is no longer "elective." Note that any treatment of established disease only should be defined as "involved field," or as defined earlier, "gross tumor with margin," whether that field encompasses, for example, the primary site and an involved node, or the primary site and the site of a resected pleural implant.

Postoperative RT After Resection with a Positive Margin (R1)

Timing of postoperative radiation after resection with a positive margin is similar to that after a negative margin resection (typically within 3 months of surgery), with the exception that care must be taken to involve the surgeon and pathologist in accurately defining the anatomy where microscopic residual disease remains. Ideally, if the ITMIG recommendations for specimen handling at the time of resection have been followed, such areas will have been clearly marked with clips.[6] Again, if immediate postoperative imaging shows no gross residual disease and no radiation is initially recommended but subsequent imaging that informs the decision for radiation shows growth of grossly visible tumor, the intent of radiation is for "recurrence" rather than "postoperative" radiation. (It is important not to confuse hemostatic material left in the operative field with an early recurrence).[7] If immediate postoperative imaging shows no gross residual disease and radiation is initially recommended but preradiotherapy imaging shows rapid regrowth of grossly visible tumor, postoperative radiation should be defined as for "gross residual" tumor after surgery and be recorded as R2 (the basic definitions and standards are defined below). Doses below 40 Gy and above 64 Gy are not considered appropriate in the postoperative setting but should be reported as described in Table 1. With the higher dose range, normal tissue tolerance must be respected. Again, doses for "hemithoracic" fields are a separate issue, distinct from the treatment of the surgical bed and are discussed below. When the tumor has been completely resected, minimum radiation fields often encompass presurgical involved areas, surgical clips, and areas where the surgeon or pathologic review indicates positive margins or the potential for residual microscopic disease. Radiation fields should be reported as above, including the categories "tumor bed with margin" or "elective sites beyond initially involved area" (as summarized in radiation field in Table 1). Nodal irradiation ceases to be elective if biopsy-proven gross disease is present.

Postoperative RT After Surgery with Gross Residual Disease (R2)

Timing of postoperative radiation after resection for gross residual disease is the same as for a negative margin or positive margin without gross residual disease: the time interval should be documented. This time period is typically within 3 months, though if a patient with gross residual disease is then treated with a planned course of chemotherapy followed by RT due to the presence of active disease, or chemotherapy followed by chemoradiation, then the time period between surgery and postoperative radiation may exceed 3 months and the radiation portion of the treatment is best described as having "definitive" intent, as radiation for progressive disease. Similarly, if radiation is not initially planned after surgery and chemotherapy is given instead, but radiation is subsequently recommended after chemotherapy and fails to arrest tumor growth, this radiation should be defined as radiation for "curative" intent, rather than "postoperative radiation." Radiation doses below 54 Gy are inad-

equate for gross residual disease. Minimum radiation fields encompass the gross disease as defined on cross-sectional postoperative imaging and surgical clips. Radiation fields should be reported as above, including the categories "gross tumor with margin," "elective sites beyond initially involved area," and/or "sites of pleural metastases." Again, nodal irradiation ceases to be elective should biopsy-proven gross disease be present (see radiation dose and radiation field in Table 1).

DEFINITIONS AND REPORTING GUIDELINES FOR PREOPERATIVE RT

Preoperative chemotherapy, radiation, or combined chemoradiation has been shown to be an effective treatment strategy for locally advanced disease. After preoperative therapy, patients should be assessed for disease response approximately 3 to 6 weeks after the completion of treatment with reimaging, to include a dedicated CT scan of the chest with contrast. If at this time, patients are deemed to be operative candidates, surgical resection should be performed followed by an assessment for postoperative RT based on the above guidelines. Indeed, if preoperative RT was delivered, this dose should be taken into account in planning any future radiation treatment, and a "composite plan" should be devised for the purposes of normal tissue tolerance doses. This composite plan will take into account for both the prior and current radiation dose, though it should be noted that the dose levels are not necessarily additive and/or often cannot be specifically quantified. If at the time of reassessment after preoperative treatment, surgery is still not a planned part of treatment, further RT can be considered using the guidelines for definitive RT described below. Nevertheless, a composite treatment plan should again be attempted, and thus, it is likely that if radiation is included in the preoperative therapy regimen, the dose of further radiation allowable will be limited.

In the preoperative setting, the treatment field should be defined and reported using the guidelines above and using all available imaging, to include the GTV with appropriate margins for microscopic spread, internal motion, and patient setup (CTV, ITV, and PTV). The technique of hemithoracic RT is described below. A dedicated CT scan of the chest with contrast is strongly recommended. Doses below 40 Gy and above 64 Gy are not considered appropriate in the preoperative setting. In the postoperative setting, the dosing guidelines above should be used and vary based on the extent of resection achieved (R0 versus R1 versus R2), intraoperative findings, and normal tissue constraints. The radiation dose and radiation field should be reported as described in Table 1.

DEFINITIVE RT FOR THYMOMA

"Definitive radiation therapy" is defined as RT delivered as the sole local modality for control of disease, although it is often combined with chemotherapy for systemic treatment. It is used in the setting of thymoma in patients who (1) are deemed to be "medically inoperable" or (2) are not operative candidates due to disease characteristics after preoperative therapy. "Medically inoperable" is defined as being unable to tolerate the appropriate surgical resection due to factors not related to the malignancy, such as age, comorbidities, and performance status. As noted earlier, "definitive radiation therapy" can also be defined as treatment in which an R2 resection has previously been performed, and thus, RT is being used as a primary local modality for curative intent, with or without chemotherapy. Treatment field guidelines should be delineated and reported as outlined above and in Table 1, to cover the GTV with appropriate margins for microscopic spread, internal motion, and patient setup variation, depending on the techniques available at the institution. A dedicated CT scan of the chest with contrast should be obtained. Doses below 54 Gy should not be considered definitive treatment.

THE ROLE OF HEMITHORACIC RT IN THE MANAGEMENT OF THYMOMA

"Hemithoracic radiation therapy" is defined as radiation encompassing the entire ipsilateral hemithorax electively in addition to the PTV. The rationale for including a hemithoracic field is that thymomas have shown to have a potential for pleural dissemination in prior studies,[8] and it is thought that low doses of radiation may sterilize this region. Appropriate treatment fields for hemithoracic RT have been defined using an anterior/posterior radiation technique approximately as follows: superior: thoracic inlet, or highest extent of disease, inferior: insertion of diaphragm, lateral: 1 cm lateral to the skin, and medial: contralateral vertebral body.[8] Nevertheless, it should be noted that the target region in this technique is the pleura and not necessarily the lung parenchyma, and although there are no studies examining using conformal techniques such as IMRT to achieve lung sparing in this setting, this will likely be a focus of future studies assessing the safety and efficacy of minimizing normal tissue dose by targeting solely the region at risk in the hemithorax. Hemithoracic RT has been used in both stage II/III disease,[9] and IVa disease.[6,7] Typical doses of hemithoracic RT range from 10 to 17 Gy in 7 to 16 fractions for low-stage disease (stages II–III), with a boost to regions at high risk of up to 50 to 70 Gy (1.8–2.0 Gy fractions) and 45 to 54 Gy in stage IVa disease with similar boost doses. The radiation treatment volumes should be defined as outlined above (GTV, CTV, ITV, and PTV). Regarding reporting guidelines (Table 1), both the radiation dose to the hemithoracic region should be reported, as well as the initial volume, with the dose and fractionation specified, and subsequent radiation to the involved tumor or regions at higher risk should be reported as the boost volume, with the same specifications.

LOCAL RECURRENCES IN RT

Despite the many advantages of more conformal radiation techniques, particularly IMRT, one potential disadvantage is the possibility of a geographical miss. This type of locoregional recurrence is defined either as progressive disease outside of the radiation field (designated as an "out-of-field" recurrence) or in the region of high dose falloff (designated as a "marginal miss"). The concept of a marginal miss with conformal techniques has been well elucidated in other malignancies such as head and neck cancer,[10–12] but there is not a consensus in the literature as to a strict definition

of a marginal miss. We propose that for reporting and database purposes, a marginal miss is defined as local recurrence in which the geographic center of the recurrence lies in the region between the prescription dose (≥100% prescription dose) and the radiation field edge, defined as ≥50% dose. Out-of-field recurrences are defined as a local recurrence in which the geographic center of the tumor is outside of the field edge or 50% isodose line. Therefore, local recurrences would be reported in one of three categories: in-field, marginal recurrence, and out-of-field. Although we acknowledge that there will always be some degree of subjectivity in defining a particular isodose line that is defined as a region of "dose falloff," and hence defining a recurrence in which expanding the radiation field by a reasonable amount may have prevented this event, these definitions will serve as a guide to data collection and potential areas of improvement in target delineation.

TOXICITY REPORTING GUIDELINES FOR THYMIC TUMORS

All toxicities related to RT for thymic malignancies should be reported according to the guidelines outlined in Table 1. Relevant toxicities include esophagitis, pneumonitis, dyspnea, dermatitis, and cardiac toxicities such as pericarditis, arrhythmias, and coronary artery disease. Because of the chronic nature of this disease and relatively high long-term survival rates, both acute toxicity, defined by the Radiation Therapy Oncology Group as within 3 months of the start of RT, and chronic toxicity, defined as adverse events occurring outside of this time period, should be recorded. Both the Radiation Therapy Oncology Group and Common Toxicity Criteria for Adverse Events criteria are acceptable, but the treating physician should specify both the toxicity scoring system and the version that is being cited.

CONCLUSION

Although many consensus guidelines pertaining to the role of RT in thymic malignancies have been published, the above recommendations serve to provide global reproducibility among outcome studies and to assist radiation oncologists by providing a basis for medical record documentation, retrospective review, and prospective assessment. By adhering to the concepts provided in this article, the end goal is to minimize ambiguity and inconsistency when defining treatment paradigms and ultimately to build an ongoing database that can be extracted and updated with limited effort and with the confidence that the radiation terms described in these guidelines do not vary based on factors such as geographic region, practice setting, or reporting date. If this aim can indeed be accomplished, it will be possible to publish future studies both more rapidly and more accurately than has been done in the past, thus accelerating progress pertaining to the safety and efficacy of radiation in this rare but serious malignancy.

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