

Enhancing the Role of Case-Oriented Peer Review to Improve Quality and Safety in Radiation Oncology

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Abstract

This report is part of a series of white papers commissioned by the American Society for Radiation Oncology (ASTRO) Board of Directors as part of ASTRO's Target Safety Campaign, focusing on the role of peer review as an important component of a broad safety/quality assurance program. Peer review is one of the most effective means for assuring the quality of qualitative, and potentially controversial, patient-specific decisions in radiation oncology. This report summarizes many of the areas throughout radiation therapy (RT) that may benefit from the application of peer review. Each radiation oncology facility should evaluate the issues raised and develop improved ways to apply the concept of peer review to its individual process and workflow. This might consist of a daily multi-disciplinary (eg, physicians, dosimetrists, physicists, therapists) meeting to review patients being considered for, or undergoing planning for, RT (eg, intention to treat and target delineation), as well as meetings to review patients already under treatment (eg, adequacy of image guidance). This report is intended to clarify and broaden the understanding of radiation oncology professionals regarding the meaning, roles, benefits, and targets for peer review as a routine quality assurance tool. It is hoped that this work will be a catalyst for further investigation, development, and study of the efficacy of peer review techniques and how these efforts can help improve the safety and quality of our treatments.

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- 1.0 Introduction
 - 1.1 Current Peer Review Recommendations Within Radiation Oncology
 - 1.2 Prior Work on Peer Review in Radiation Oncology
 - 1.3 Programmatic Peer Review and Maintenance of Certification Programs
 - 1.4 Peer Review: QA for Professional Qualitative Decisions
 - 1.4.1 Peer Review Versus Process Control
 - 1.4.2 Case-Specific Peer Review
 - 1.5 Goal of Current Report
 - 2.0 The Traditional Approach to Case-Oriented Peer Review in Radiation Oncology
 - 2.1 Chart Rounds
 - 2.2 Prospective Pre-Treatment Tumor Boards
 - 3.0 Categorizing Possible Targets for Peer Review
 - 3.1 General Considerations
 - 3.2 Targets for Peer Review
 - 3.3 Pre-Planning, Physician-Focused Tasks
 - 3.4 Treatment Planning–Dosimetry/Physics-Focused Tasks
 - 3.5 Treatment Delivery–Therapist-Focused Tasks
 - 3.6 Prioritizing the Possible Targets for Peer Review
 - 3.7 Operation Implementation/Prioritization
 - 4.0 Implementing Effective Peer Review
 - 4.1 Example Process Improvements
 - 4.2 Example Technological Improvements
 - 4.3 Peer Review in the Context of Evolving Roles
 - 4.4 Peer Review in the Context of Education
 - 5.0 Discussion
 - 6.0 Summary of General Recommendations
 - 7.0 Conclusions
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Legend

2D –	2-dimensional
3D –	3-dimensional
4D –	4-dimensional
ABC –	Active Breathing Control
ABR –	American Board of Radiology
ACR –	American College of Radiology
ACRO –	American College of Radiation Oncology
AAMD –	American Association of Medical Dosimetrists
AAPM –	American Association of Physicists in Medicine
ASCO –	American Society of Clinical Oncology
ASRT –	American Society of Radiation Therapists
ASTRO –	American Society for Radiation Oncology
CBCT –	Cone Beam Computed Tomography
CME –	Continuing Medical Education
CMS –	Centers for Medicare and Medicaid Services
CRT –	Conformal Radiation Therapy
CT –	Computed Tomography
CTV –	Clinical Target Volume
DRR –	Digitally Reconstructed Radiograph
DVH –	Dose Volume Histogram
EMR –	Electronic Medical Record
FMEA –	Failure Modes Effects Analysis
IGRT –	Image Guided Radiation Therapy
ITV –	Internal Target Volume
IMRT –	Intensity Modulated Radiation Therapy
MIP –	Maximum Intensity Projection
MLC –	Multi-leaf Collimator
MOC –	Maintenance of Certification
MU –	Monitor Unit
PAAROT –	Performance Assessment for the Advancement of Radiation Oncology Treatment
PQI –	Practice Quality Improvement
PRAT –	Peer Review Audit Tool
PTV –	Planning Target Volume
QA –	Quality Assurance
QC –	Quality Control
RANZCR –	Royal Australian and New Zealand College of Radiologists
RT –	Radiation Therapy
RTOG –	Radiation Therapy Oncology Group
SBRT –	Stereotactic Body Radiation Therapy
SSD –	Source to Skin Distance
TG –	Task Group
US –	United States

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White Papers on Patient Safety in RT

The full report is part of a series of white papers addressing patient safety commissioned by the American Society for Radiation Oncology (ASTRO) Board of Directors as part of ASTRO's Target Safety Campaign. The full length document was approved by the ASTRO Board of Directors on September 11, 2012 and has been endorsed by the American Association of Physicists in Medicine (AAPM), American Association of Medical Dosimetrists (AAMD), and the American Society of Radiologic Technologists (ASRT). The document has also been reviewed and accepted by the American College of Radiology's (ACR) Commission on Radiation Oncology. These organizations have a long history of supporting efforts toward improving patient safety in the United States.

This report is related to other published reports of the ASTRO white paper series on patient safety, including those on intensity modulated radiation therapy (IMRT) and stereotactic body radiation therapy (SBRT), and those still in preparation. There are sections of this report that defer to guidance in these reports.

1.0 Introduction

In the last several years, there have been several high profile reports questioning the safety of radiation oncology. As modern radiation oncology grows ever more advanced, quality assurance (QA) procedures must evolve to keep pace and maintain safety. Peer review, also known as audit and feedback, is a valuable tool that is central to quality management or QA programs.¹ Peer review has been defined to be "the evaluation of creative work or performance by other people in the same field to enhance the quality of work or the performance of colleagues."¹

A recent meta-analysis of randomized trials testing the effects of peer review (audit and feedback) on objective professional practice or health outcomes found that audit and feedback can be effective in improving professional practice.² While peer review has been accepted as an important aspect of quality efforts (especially of physician treatment decisions) in radiation oncology for many years, there is currently little guidance about specific peer review processes from radiation oncology professional organizations, and there is limited published literature on peer review in radiation oncology. The goals of this report are to

- a. provide a broad summary of current recommendations, practice, and associated context for peer review activities in radiation oncology,
- b. review potential targets for peer review, and discuss their prioritization and associated rationale, and
- c. propose improvements in processes or technol-

ogy that may facilitate/improve peer review, and acknowledge associated challenges.

1.1 Current Peer Review Recommendations Within Radiation Oncology

Radiation oncology professional organizations have provided recommendations regarding a number of technical QA procedures (eg, AAPM guidelines or ACR Practice Guidelines and Technical Standards). However, guidelines on peer review specifically focusing on medical decision-making and technical expertise are sparse.

The ACR has specific practice guidelines for radiation oncology that describe some peer review functions. For example, the 2009 ACR Practice Guideline for Radiation Oncology "Individual Physician Peer Review" section states that either a hospital-wide or a facility-based physician peer review program must be employed and states the difficulty solo practitioners face in peer review.³ However, the guideline does not give any specific recommendations on the frequency, mechanics, or metrics of peer review.

More formally integrated guidance on peer review in radiation oncology has been provided by the Royal Australian and New Zealand College of Radiologists (RANZCR). RANZCR has developed a peer review audit instrument. They have further refined this instrument into the 2006 Peer Review Audit Tool (PRAT).⁴

1.2 Prior Work on Peer Review in Radiation Oncology

Several papers describe that chart rounds should include a component of peer review to improve quality of care.⁵⁻⁶ Another report concludes that peer review may remedy documentation problems and promote physician recertification.⁷ One large study assessed the real-time pre-treatment review of 3052 treatment plans over an 8-year period in Ontario, Canada. They found that such pre-radiotherapy peer review was feasible, and that pre-treatment plan modifications were recommended in approximately 8% of cases.⁸ A similar prospective study noted peer review recommended changes in 8/208 patients (4%).⁶ A post-treatment peer audit of ~80 cases also noted that ~5% of patients had apparent controversial/concerning medical decisions made regarding things such as treatment intent, dose, and fractionation.⁹

These later 2 studies used PRATs created by RANZCR and The Cancer Institute in Singapore. These PRATs have evolved over time in response, in part, to systematic assessments of their reproducibility.⁹ Such tools have the potential to improve practice quality, alter patient management,^{2, 9-10} and provide an effective means to document changes in patient management.⁵ These audit instruments often include assessment of "behavior" items (eg, documentation

compliance) in addition to “performance” items. The experiences of these groups, and components of their existing audit tools, may prove useful in future peer review initiatives.

A recent survey was conducted to estimate the pattern of “peer review chart rounds” within North American academic radiation oncology facilities.¹¹ The chief residents in 57 out of 71 training programs responded to an anonymous web-based survey. Their key findings include: (1) providing protected time and monitoring attendance was associated with better participation by senior faculty, (2) review of routine external beam cases was far more common (where 80% of institutions reporting peer review of all cases) than for radiosurgery or brachytherapy (where 58%, and 40%-47% of centers reported review of cases, respectively), (3) 60% percent of respondents reported that the duration of chart rounds was < 2 hours per week (range, 1-6 hours), (4) the median time spent per patient was 2.7 minutes (range, 0.6-12 minutes) (5) minor and major changes were relatively uncommon as a result of chart rounds; 14% of respondents estimated that minor changes (eg, small multileaf collimator change or request to repeat a port film) were requested in $\geq 20\%$ of cases, and 61% of respondents estimated that minor changes were requested in <10% of cases; 11% of respondents estimated that major changes (eg, to the dose prescription or treatment plan) occurred in $\geq 10\%$ of cases, and 75% of respondents estimated that major changes occurred in <10% of cases.¹¹ Peer review sessions generally should include broad members of the clinical team, and not be limited to physicians.¹¹⁻¹⁴

1.3 Programmatic Peer Review and Maintenance of Certification Programs

One useful application of peer review is aimed at the overall programmatic review of a department or group, led by peers (typically) from outside the organization. ASTRO, ACR¹⁸, and the American College of Radiation Oncology (ACRO) all have long-standing practice accreditation programs that utilize peer review. In addition, AAPM Task Group (TG)-103 describes independent peer review of medical physics programs.¹⁴ A systematic review of this type can be useful to improve safety and quality. This type of peer review is beyond the scope of this report, and will not be discussed further.

In the United States, the current American Board of Radiology (ABR) Maintenance of Certification (MOC) Part IV, Practice Quality Improvement (PQI) requirements dictate that some PQI projects be society- or organization- initiated (referred to as “Type 2” projects). Currently, the ACR has a Type 2 program called RO-PEERTM and ASTRO has a Type 2 program called Performance Assessment for the Advancement of Radiation Oncology Treatment (PAAROT).¹⁵ While both RO-PEER and PAAROT include elements of peer re-

view, these programs are only required once every 10 years, do not qualify as ongoing peer review, and will not be discussed further.

1.4 Peer Review: QA for Professional Qualitative Decisions

1.4.1 Peer Review Versus Process Control

This paper concentrates on patient-specific peer review in radiation oncology, ie, peer review for items linked to a specific patient (eg, dose distribution), rather than global processes that effect patients more broadly (eg, machine calibration). In our field, patient care processes can be broadly divided into a series of medical (often qualitative) decisions that often do not have clear right/wrong answers (eg, a physician’s prescription of dose/volume) and a series of more quantitative technical tasks or programs to implement the prescribed treatment (typically executed by teams of therapists, dosimetrists, and physicists) (Figure 1) (*See page 6*). Many QA/quality control (QC) measures are aimed at ensuring accuracy of these technical activities. These QA/QC checks typically confirm quantitative measurements involving equipment (eg, radiation output), or procedural checks confirming that specific actions (eg, data transfer between computer systems) and decisions have been made and documented correctly. These kinds of quantitative technical issues and quality assurance procedures that can be addressed by *technical procedures (right-hand side of Figure 1)* are not the subject of this report. Rather, this report concentrates on ways that peer review can be used to help improve the safety and quality related to *professional decisions* made by members of the radiation oncology team (*left-hand side of Figure 1*).

1.4.2 Case-Specific Peer Review

Peer review of case-specific medical/professional qualitative decisions, that involve judgments and tradeoffs, may help to improve quality. For example, medical decisions regarding prescription dose and target volumes can, and ideally should, be reviewed by other physicians, as these decisions usually are based on many factors that cannot easily be enumerated or quantified. Indeed, substantial inter-observer variation in image segmentation of targets and organs-at-risk has been noted in several clinical settings.¹⁶⁻¹⁷ Peer review can also be helpful to identify the evolution of best practice (eg, the practitioner being unaware of a recent large randomized trial pertaining to the patient’s situation). In all cases, the peer review process may provide a continuing educational function, thus potentially improving the quality of care more broadly (ie, beyond the individual patient being discussed).

The underlying premise of peer review, in general, is that review by an appropriately qualified independent person (and/or larger and more diverse group of people)

FIGURE 1

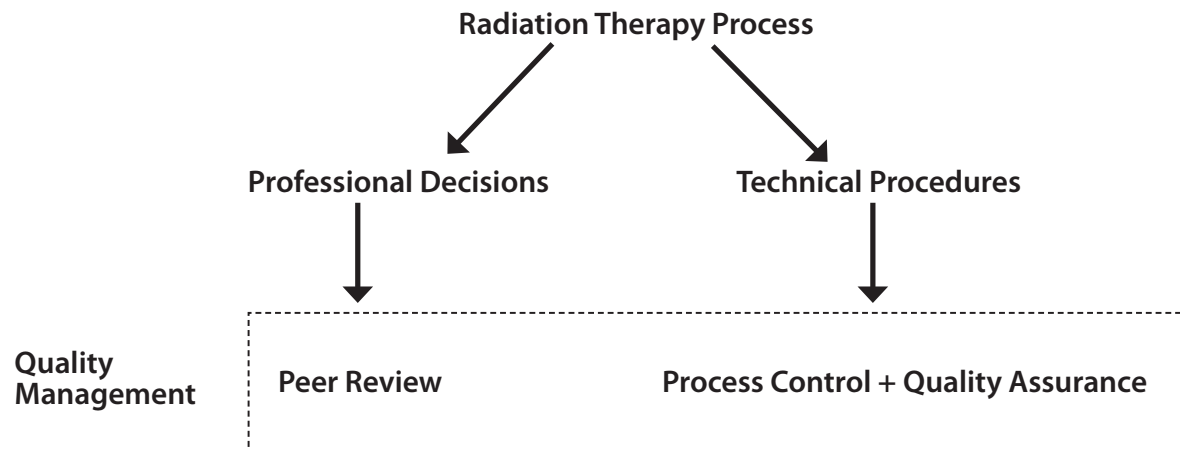


Figure 1: A quality management program must address medical/qualitative steps (left side) as well as technical/quantifiable process-related steps (right side) to implement the medical directive. The left side is the focus of this report.

will improve the result of a decision-making process when compared to a decision made by a single individual.² For a decision which has many different components (for example, the decision about what modalities of treatment should be pursued in a complex case), the discussion of the case between experts with relevant but diverse backgrounds may improve quality.^{15,18} Where it is practical and reasonable, peer review sessions generally should include broad members of the clinical team, and should not be limited to physicians.¹¹⁻¹⁴

1.5 Goal of the Current Report

Recognizing that peer review will play an important role in improving radiation oncology, ASTRO has commissioned this “white paper” on peer review. This report aims to highlight targets, methods, and possibilities for improving peer review to better safety and quality for patients treated with radiation therapy.

2.0 The Traditional Approach to Case-Oriented Peer Review in Radiation Oncology

2.1 Chart Rounds

Peer review is widely, though inconsistently, practiced among radiation oncologists, and the phrase “peer review” is almost universally taken to mean the review of patient treatment information at “chart rounds.” During these sessions, members of the treatment team (eg, physicians, therapists, dosimetrists, physicists, nurses, etc) review each physician’s cases, looking at doses, fields, treatment plans, patient setup, and other issues. Minor (ie, MLC [multileaf col-

imator], change/repeated port film) or major (dose prescription change/replan) changes may be made. This type of review has been imbedded in the radiation therapy process for years, and is documented in many reports.^{11, 16, 18} A recent survey suggested that such routine peer-review occurs in essentially all North American centers with accredited residency training programs.¹¹

2.2 Prospective Pre-Treatment Tumor Boards

Tumor boards are a second form of peer review, common in many centers. Typically, physicians from multiple disciplines and other members of the healthcare team (eg, nurses, social workers, etc) discuss new patients, or cases with upcoming decision points. The group renders opinions and advice to specific members of the team and often reviews the ongoing management plan for individual patients (eg, whether or not to use RT at all, and the use of concurrent chemotherapy). Such a multidisciplinary discussion is often crucial in assuring optimal care reflective of diverse knowledge and experiences from all relevant team members, especially in complex cases. Tumor boards discussing patients whose treatment has already been initiated are less useful.¹⁹

3.0 Possible Targets for Peer Review

3.1 General Considerations

Modern radiation therapy requires team members to perform tasks that are not easily verifiable with a quantitative QA or QC check. Peer review has traditionally been applied to the physician’s selection of treatment parameters such as doses and targets. Non-physician-focused issues are also amenable to peer review. For

example, treatment plan quality often cannot be checked with a simple “yes” or “no” answer, there may be potentially “better” plans which may improve upon a plan that just satisfies the “minimal acceptable” constraint for each target and normal structure. Likewise, the decision about what kind of daily image guidance is best for a complicated case may incorporate a feature such as the cooperation of the patient. Such facets of complex cases cannot all be confirmed simply by filling out a checklist. Therefore, in this paper we broadly consider issues that might benefit from peer review, in addition to physician-based decisions checked by other physicians.

3.2 Categorizing Targets for Peer Review

Candidate decisions/actions that can be targeted for peer review are outlined in Table 1 (*see page 8-9*). These decisions/actions are divided into 6 categories corresponding to the simplified radiation therapy process shown – essentially a series of process steps, or tasks, roughly in chronological order. This list suggests potential targets for peer review, ie, the qualitative decisions or actions. A refined prioritization of targets is provided in section 3.6 (“Prioritizing the Possible Targets for Peer Review”). It is expected that relevant organizations will make more explicit recommendations on the topic of peer review, and that those recommendations will evolve over time as additional evidence uncovers other useful targets for peer review.

For many of the defined tasks, 1 primary team member is typically ultimately responsible for the task/decision, and those tasks/decisions usually represent opportunities for peer review. For other steps, decisions are reached based on the input of multiple team members, and peer review of the multiple inputs may also be helpful. For each task, the table describes the goal of peer review, the person who typically performs the peer review, the ideal timing, and, where applicable, features that may facilitate the peer review.

3.3 Pre-Planning – Physician-Focused Tasks

The first series of process steps are components of medical decision-making that come before the treatment planning process. These are largely qualitative decisions, often without clear right or wrong answers. Physicians are needed to perform most of the peer review for these items. Optimal peer review for these items is performed prior to treatment planning as changes in these items will influence the planning process. For example, changing which nodal volumes to include in the clinical target volume (CTV) will have a dramatic impact on a treatment plan. Several of these early pre-planning decisions are made by the physician with guidance from therapists, dosimetrists, and physicists, including patient positioning (which position will spare normal tissue and

be most comfortable and reproducible), motion management, planning target volume (PTV) expansion margins (how reliable the setup is likely to be and how much expansion of a target can safely be performed), and set-up routine. These items are often influenced by measurable quantitative factors such as the degree of internal target motion. For some of these items, there are objective treatment guidelines that might be useful in streamlining/automating peer review.

3.4 Treatment Planning – Dosimetry/Physics-Focused Tasks

The latter table entries largely focus on treatment planning and treatment delivery (Table 1). Physicians, dosimetrists, therapists, and physicists all have critical roles in these tasks and in their peer review. The diversity of individuals involved reflects the large number of hand-offs and “back and forth/iterations” that occur during the planning/delivery process. The very nature of these processes demands a rigorous review and QA system. Some of the tasks listed can be readily quantified, (eg, IMRT QA or comparison of setup images to planning images), while others are more subjective (eg, does the treatment plan appropriately balance the competing [and mutually exclusive] desired plan constraints).

Peer review of treatment planning raises unique issues. The seemingly-infinite number of possible treatment plans, and the large amount of time needed to generate and QA a plan, make peer review of treatment planning challenging. Often the planner and physician’s experience dictate when the “best” possible plan has been generated. This is a critical step where peer review might be particularly helpful. A different, or a more experienced, dosimetrist/planner might be able to create a clever solution to a challenging geometric problem. These tricks of the trade are often passed down from generation to generation. Many of these technology-related tasks can be checked with peer review conducted at specific points in the treatment planning process. Furthermore, there are issues to consider that are not completely medical, such as whether the patient has transportation and/or family support, whether the patient will come for a full course of therapy, whether he can follow instructions, etc. All of these things come into play during planning. For example, complicated treatment approaches may not be appropriate if the patient is uncooperative.

3.5 Treatment Delivery – Therapist-Focused Tasks

Therapists are at the “end of the line” and are often expected to perform a broad review of all of prior activities. For example, “Is this the correct patient? Are we treating the correct site? Is there overlap with a previously-irradiated field? Do the fields and monitor

Table 1: Comprehensive List of Potential Targets for Peer Review

Broad Process Steps [#]	Process or Decision [^]	Person who Performs the Task	Decision(s) to be Reviewed	Person who Performs the Peer Review	Ideal Timing
1. Consultation, decision to include radiation as part of the multi-modality approach	To treat or not to treat	Physician	Yes/No	Physician	Before/after consultation and before simulation
	When to treat	Physician	Timing	Physician	After consultation and before simulation
	Treatment intent	Physician	Curative/Palliative	Physician	
	Integrate RT with other modalities/services?	Physician	Optimal sequence of surgery/chemotherapy/RT	Physician/Tumor board	
	Prescribe medication(s)	Physician	Drug indication, choice, dose, monitoring, etc.	Physician	
	General radiation treatment approach	Physician	eg, Brachytherapy/external beam/3D CRT/IMRT/protons	Physician	
2. Simulation, imaging, immobilization	Immobilization	Radiation Therapist, Physician	Is immobilization appropriate for patient intent?	Dosimetrist, Physicist	Before or during simulation
	Motion management strategy	Physician, Physicist	How is respiratory motion handled? 4DCT, gating, ABC, abdominal compression, etc?	Physician, Physicist	At simulation
	Motion management technique implementation decision	Physicist, Physician	How best to represent/address 4D data (eg, how to bin scans, MIP images, creation of ITV)?	Physicist, Dosimetrist	At simulation
	Reproducibility of setup (patient comfort, cooperation and stability)	Therapist, Physicist, Physician	Acceptable/Unacceptable	Dosimetrist, Physicist, Physician, Therapist	At simulation
	The need for multi-modality imaging*	Physician	Are the imaging choices correct?	Physician, Physicist	Before simulation/planning
3. Anatomical model definition	Target definition*	Physician	Correct target choice, technical quality of contouring	Physician, Dosimetrist, Physicist	Before planning
	Image registration/fusion*	Dosimetrist, Physicist	Is it correct? Or is there room for variation? Is it acceptable? Appropriate compromises made in fusion?	Physicist, Physician (final approval)	Before planning
	Image segmentation (normal tissue volumes)	Dosimetrist, Physicist, Physician	Medical acceptability and technical accuracy	Dosimetrist, Physicist, Physician (final approval)	Before planning
	Import correct image sets into planning system	Dosimetrist, Physicist (technical implementation)	Are correct image sets included?	Physician (overall), Physicist (quantitative)	Before planning

(continued on next page)

Table 1: Comprehensive List of Potential Targets for Peer Review (continued)

Broad Process Steps [#]	Process or Decision [^]	Person who Performs the Task	Decision(s) to be Reviewed	Person who Performs the Peer Review	Ideal Timing
4. Planning, optimization	Planning directive/ goals (eg, dose/volume constraints, goals for normal tissues and target[s])	Physician, Physicist, Dosimetrist	Appropriateness for intent of treatment	Physician, Physicist, Dosimetrist	Before planning
	Prescribed doses/ fractionation	Physician	Appropriate/Unacceptable	Physician	Before planning
	Clinical plan quality; eg, achieved doses/volumes	Physician, Physicist, Dosimetrist	Acceptable/Unacceptable	Physician, Physicist, Dosimetrist	End of planning
	Technical plan quality (completeness, complexity, as good as reasonably achievable, acceptable to meet the prescription intent)	Dosimetrist, Physicist	Acceptable/Unacceptable	Physicist	End of planning
	Planned method for setup verification (eg, imaging)	Dosimetrist, Physicist	Appropriate for this plan/margins?	Physicist	After planning
5. Plan preparation	Tolerance levels for setup verification	Dosimetrist, Physicist	Appropriate for the verification method and plan/margins	Physicist	After planning
	Need for adaptation during treatment	Physician	Appropriate choices of adaptation expectations and methods (CBCT, re-sim, etc.)	Physician, Physicist	End of planning
	Evaluation of QA (eg, patient-specific IMRT QA)	Physicist	For “problem” QA points - is it acceptable?	Physicist	After planning
6. Treatment	Daily global treatment setup accuracy	Therapist	Does setup globally appear acceptable?	Therapist, Physicist, Physician	At treatment
	Image guided isocenter verification	Therapist	“Localization or portal images” acceptable relative to planning information (DRRs, etc)	Therapist, Physicist, Physician	At treatment
	Motion management application	Therapist	Verify motion management strategy and implementation within the desired tolerance.	Therapist, Physicist, Physician	At treatment

[^]Bolded items have the highest priority for peer review.

[#]Simplified Radiation Therapy Process Steps: (1) Consultation/decision to treat -> (2) Simulation/imaging/immobilization -> (3) Anatomical model definition -> (4) Planning/optimization -> (5) Plan preparation -> (6) Treatment -> (7) Follow-up

Abbreviations: RT (Radiation Therapy); 3DCRT (3-dimensional Conformal Radiation Therapy); IMRT (Intensity Modulated Radiation Therapy); 4DCT (4-dimensional Computed Tomography); ABC (Active Breathing Control); ITV (Integrated Target Volume); CBCT (Cone Beam Computed Tomography); QA (Quality Assurance).

*These items are combined in Table 2

units (MUs) make sense given all of the above?” Many of these have clear right and wrong answers and are in reality “quality/process control” issues (ie, not technically “peer review”). However, almost all treatment delivery errors manifest themselves at the treatment machine. Given this fact, it is clear that in order to maximize safety and quality, multiple therapists are needed at the treatment machine to check on each other, verify all the necessary information, and try to prevent upstream errors from getting to the treatment, while also using peer review on qualitative issues such as setup accuracy, immobilization, and image review.

Assigning more than a single therapist to each treatment machine is an established idea. In the “cobalt era,” the standard was often to have 1 therapist per machine. The increased complexity of linear accelerators led to placing 2 or more therapists per machine, at least in part, to check each other’s work. However, many therapists often use a “divide and conquer” approach where each of the therapists performs different tasks for speed and efficiency, and this may undermine therapist peer review. This situation only gets more complex as additional systems (image guided radiation therapy [IGRT], motion management, gating, etc) become more commonplace.

Modern radiation therapy expects the radiation therapists to perform numerous physical tasks in the treatment room (eg, patient setup, verification of source to skin distances [SSDs], light fields, and laser marks, placement of bolus and/or other machine accessories); at the treatment machine console (eg, retrieving and entering data into medical records, image review/manipulation, controlling the complex machinery used for treatment, communicating with other team members, billing); and elsewhere (eg, retrieving patients from, or escorting patients to, the waiting room, clinic, or other locations), all often within a limited slot. Having defined tasks performed in multiple discrete locations promotes the divide and conquer approach described above. However, given the many varied tasks and speed with which they are performed, the use of a second person to review the actions, measurements, data entry, and machine control aspects of the therapists’ job is a critical part of a good QA program. The second set of eyes is a crucial check of all the technical steps performed by the therapists during each treatment fraction. The use of time-outs (similar to a pre-surgery checklist in an operating room) to verify the physician’s prescription, the prescribed dose programmed into the machine, and the patient’s identity help the therapist team review these most crucial aspects of a treatment.

Not all of the therapist tasks are quantitative and able to be checked technically with a right or wrong answer. For example, patient setup is a qualitative action, as positioning of the human body in a reproducible and precise way is a matter of tolerances and decisions, rather than specific right and wrong actions. Peer

review is a crucial part of how a good team of therapists decides when the patient positioning is “good enough.” A second qualitative decision is the typical review of image-guidance data followed by a decision about the acceptability of the localization. This process can involve identifying hard-to-see structures on images, registration with sub-optimal information, distortions or mismatches that cannot be completely resolved, and many other qualitative aspects. The use of peer review methods is likely to improve the quality of the decisions made every day during the image guidance process.

3.6 Prioritizing the Possible Targets for Peer Review

Table 1 (see pages 8-9) includes a lengthy list of possible peer review targets, and addressing each item is not practical. Further, peer review is burdensome and has opportunity costs, and thus may yield unanticipated negative consequences. One must prioritize the peer review targets that are most likely to have a meaningful impact on patient outcome (Figure 2) (See page 11). Candidate “high priority” targets should be those with a high potential risk to the patient, and a low probability that an “error” will be detected downstream without a peer review intervention (Figure 3) (See page 11). There are some data to help guide this prioritization. In the studies addressing peer review from Boxer et al⁶ and Brundage et al,⁸ target volume coverage was the item most often changed during peer review. In the Brundage study, 8% of plans were identified as requiring modification by the peer review process. The most common reasons for modification related to PTVs (31%), protection of critical structures (15%), selection of treatment volumes (eg, nodal volumes included or excluded, 11%), selection of dose (11%) and dose distribution (6%). These domains correspond to current patterns of peer review in Ontario.⁸

Another reasonable way to identify priority targets for peer review is the use of a failure modes and effects analysis (FMEA). In a study conducted at Johns Hopkins University,¹⁶ the top 5 tasks with the highest risk probability included: wrong isocenter used, wrong markings used, incorrect patient in the record and verify system, incorrect contours used, and wrong computed tomography (CT) simulation data entered for the patient.¹⁶ By identifying which items have a higher risk of error, it may be easier to allocate resources optimally to enhance the utility of peer review. However, this approach is not ideal, as many of the events that occur in the clinic are not predicted by the FMEA (Ford, personal communication, 2011). Additional work is certainly needed to refine this prioritization. The recent survey of North American teaching centers noted that the issues most commonly modified by peer review related to normal tissue exposure, the prescribed dose/fractionation schedule, target coverage, and treatment technique.¹¹

FIGURE 2

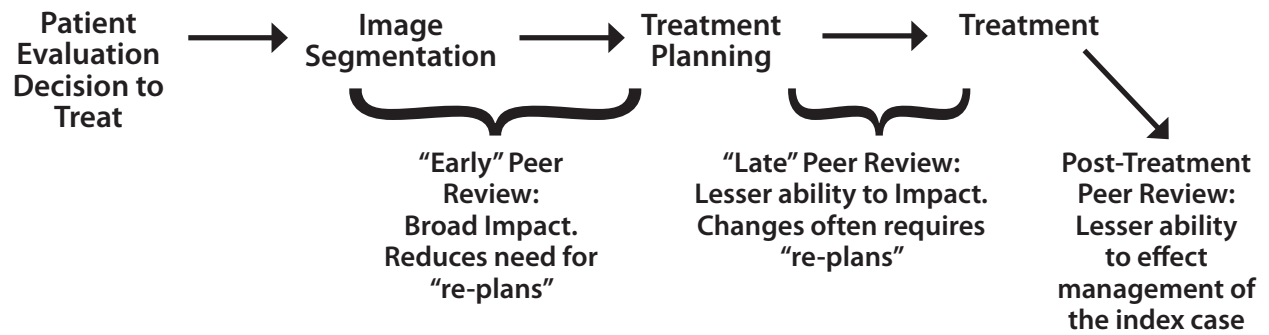


Figure 2: The use of peer review earlier in the process may have broader impact and help to reduce the need for re-plans. A number of physician decisions (eg, image segmentation) are qualitative and may be well-suited for peer review. It is often more challenging to make changes to the plan once treatment has been initiated (Adapted with permission from Chera et al.²⁵)

FIGURE 3

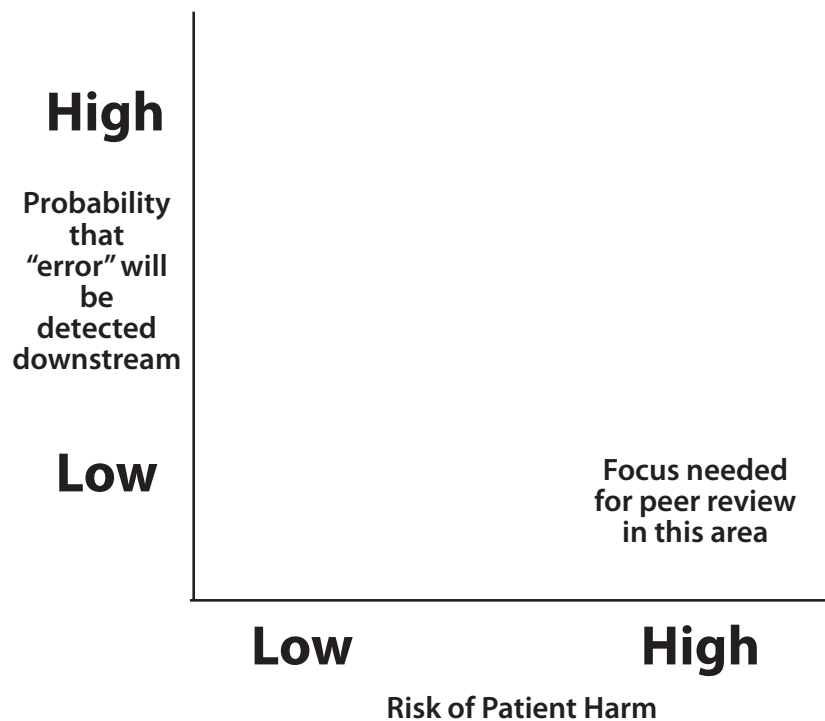


Figure 3: Candidate items for peer review might be categorized by their potential risk to the patient (x-axis), and the probability that the “error” will be detected “downstream” (y-axis) during subsequent steps in the patient’s care. Items that are of both high risk and otherwise hard to identify downstream, are likely the most meaningful/useful to address by peer review “upstream” (ie, at the point that they are implemented/created).

Prioritization, associated justifications, and applicable clinical situations of the targets for peer review are listed in Table 2 (*See page 13*). Specific recommendations for these targets are given below. In all of these recommendations, it is understood that the physician is ultimately responsible for all aspects of a patient's treatment, though other members of the radiation oncology team will often be directly responsible for performing a task and its associated peer review.

1) Decision to treat: The decision to treat a patient with radiation is first made by the treating physician. Peer review of the decision to treat with radiation should ideally be made prior to the initiation of the treatment and ideally before the planning process begins. This is considered as Level 2 since this decision is often aided by clinical practice guidelines. Retreatment settings are often particularly challenging (especially when normal tissue constraints in the target volume are compromised) and represent a clinical setting where peer review of this decision is often useful.

2) General treatment approach: The general approach includes parameters such as:

- a. treatment goal (eg, curative, adjuvant, or palliative);
- b. treatment modality (eg, brachytherapy vs various external beam approaches);
- c. non-conformal or conformal, image guidance approach (eg, cone beam); and
- d. motion management (eg, gating).

Since these decisions are usually made by the physician in consultation with dosimetrists, physicists, and therapists, peer review of these issues should ideally be multidisciplinary. The timing of this peer review should be pre-treatment, and during the planning process, as much of the information needed to judge a decision becomes available only after the planning process has been initiated. This is considered as Level 3 since these decisions are often aided by clinical practice guidelines and recommendations.

3) Image segmentation/contouring: Delineation of the target volumes is the physician's responsibility. Normal tissue segmentation is typically done primarily by dosimetrists, physicists, or other specially trained staff. Structure delineation is often guided by multi-modality image registration, which is also typically performed by dosimetrists, physicists, or other specially trained staff. Peer review of segmentation/fusion (as well as the images chosen for segmentation) should ideally be done prior to treatment planning, as much of the subsequent work is dependent on the details of the segmentation and/or fusion. This is one of the most important medical decisions that likely would benefit from peer review.

Since there are significant inter-patient variations in the target volumes and since mis-targeting can lead to poor clinical outcomes, this is considered as one of the most critical areas for peer review (ie, Level 1), especially in patients being treated with curative intent and with highly-conformal approaches (as is often the case for IMRT and SBRT). Segmentation of the normal tissues is considered Level 3, since this is often guided by atlases.

4) Planning directive: The planning goals (eg, desired dose/volume parameters/limits) are often based on existing guidelines. Nevertheless, these decisions are often somewhat qualitative, and are thus considered Level 2. This peer review should ideally be performed prior to initiation of treatment planning (particularly if the planning process is anticipated to be time-consuming and highly dependent on the planning goals), or prior to the initiation of therapy (if the planning process is less time consuming and less dependent on the planning goals). This might be most important in the settings where there are not clear clinical guidelines (eg, the retreatment setting) or when normal tissue and target constraints are in conflict. Similarly, changes in the planning goals or image segmentation made during the course of therapy (ie, adaptive therapy) may also benefit from peer review.

5) Technical plan quality: Evaluation of the plan's quality, relative to the planning goals, is usually made by the treating physician, in consultation with the dosimetrist/physicist who are typically familiar with the technical trade-offs and compromises made during planning. Peer review for planning evaluates 2 types of decisions from the planning process: the physician-driven clinical tradeoffs (ideally addressed through physician peer review), and the more technical aspects of the plan's ability to achieve the desired dose-volume results with reasonable complexity and deliverable fields (ideally addressed through dosimetrist/physicist peer review).

6) Setup accuracy and consistency: A radiation therapist is responsible for daily setup accuracy, and thus a second radiation therapist should ideally provide daily review; ie, 1 therapist setting the patient up with a second verifying, or the 2 therapists working together, and checking each other. In more challenging cases (eg, SBRT), a physicist and/or physician should also provide peer review of the therapist's activities. Similar peer review should ideally be performed for other therapist activities such as review of daily pre-treatment setup images, or review of respiratory gating parameters. This is identified as a critical target for peer review, especially in curative cases, and in IMRT and SBRT cases where port films do not provide an independent assessment of the treated volume.

These specific recommendations are made for

Table 2: Prioritization of Targets for Peer Review

Level 1 indicates highest priority for peer review (where there are marked inter-patient variations), Level 2 next highest (where there are often guidelines/atlas to aid in decision), and Level 3 the next (other targets for peer review).

Item for Peer Review	Prioritization	Rationale for Priority Level	Timing of Peer Review and Associated Comments	Example Clinical Situations where Peer Review is Anticipated to be Particularly Useful
1) Decision to include radiation as part of treatment	Level 2	Guidelines often exist, but these decisions are often individualized	Pre-therapy preferred	Unusual/non-guideline cases
2) General radiation treatment approach	Level 3	There are many guidelines and best-practice statements that address this issue. If standard dose/volume constraints are respected, patient risks are low regardless of the specific RT approach taken.	Pre-radiation preferred. Altering some aspect of the treatment approach once RT has been initiated can be cumbersome (eg, image guidance approach), while other aspects are more easily changed during RT. The safest environment is one where mid-treatment changes are minimized.	Re-treatment cases
3) Target definition*	Level 1	Every patient’s tumor is different and visualization on different types of images can vary. Each image fusion is unique.	Pre-treatment peer review of how targets are defined (eg, which images and which “pixels”) is critical as mis-targeting can lead to poor clinical outcomes. Pre-planning review is ideal but is not critical for every case.	Tight margins; eg, SBRT
4) Normal tissue image segmentation	Level 3	There are atlases for normal tissues.	Review of normal tissues can be done during RT since the risks are less (especially for fractionated regimens). Normal tissue pre-RT peer review needed for single and hypo-fractionation cases.	Tight margins; eg, SBRT
5) Planning directive (Dose/volume goals/constraints for targets and normal tissues)	Level 2	Patient risks are low if standard dose/volume limits are respected. Guidelines and best practice recommendations often exist, but these decisions are often individualized.	Pre-planning or pre-treatment	
6) Technical plan quality	Level 2 First day is Level 1, especially for curative cases. Other days are Level 2.	Normal tissue dose/volume guidance documents are generally available, but the compromises between normal tissue versus target doses are often patient-specific.	For conventional fractionation, this may be acceptable to perform during RT, as there is usually an opportunity to alter the plan. The safest environment is one where mid-treatment changes are minimized.	IMRT, SBRT
7) Treatment delivery (eg, patient setup)		The first day’s setup is critical to avoid systematic errors and their propagation.	Therapist peer review of setup must be done pre-RT for the first fraction, and ideally for all subsequent fractions. Portal or localization image peer review must be done before the second treatment. Physicist and physician involved with pre-treatment QA for complex cases (eg, SBRT).	IGRT (since portal or localization imaging often does not provide independent assessment of target volume location)

*Target definition includes the decision regarding the need for multimodality imaging, the fusion of the images, and the target definitions on the images.

Abbreviations: RT (Radiation Therapy); SBRT (Stereotactic Body Radiation Therapy); IMRT (Intensity Modulated Radiation Therapy); QA (Quality Assurance); IGRT (Image Guided Radiation Therapy)

the current technical state of affairs. As clinical care evolves, the recommendations on peer review will also have to evolve. For example, real-time adaptive radiation therapy will present additional peer review challenges. On the other hand, we expect that some needs for peer review will be reduced as future technologies provide alternative/complementary means of oversight and decisions change from qualitative to quantitative.

3.7 Operational Implementation/Prioritization

Practitioners will need to determine how to optimally operationalize these specific recommendations within their clinics. Regularly-scheduled meetings of involved staff often provide a good venue for peer review (eg, multi-disciplinary “chart rounds”), as is the practice in many centers.¹¹ Having systematic and regularly scheduled meetings may help to incorporate peer review into the routine clinical workflow (rather than it being seen as an “add on”). Frequent regular meetings (eg, daily “huddles”) might be needed to optimize certain peer review tasks.

The decisions about which tasks can benefit from peer review, and the timing of this review (ie, prior to initiation of planning, prior to initiation of treatment, or during treatment) are complex. Peer review can be a time consuming process that is difficult to manage, monitor, implement, and document. Time spent on peer review carries opportunity costs as well (ie, the time and effort could have been spent on other endeavors). Nevertheless, peer review is, and will continue to be, a very important tool in assuring high quality care, particularly for non-technical decisions faced by physicians and other professional staff. The necessary time and resources should be allotted to facilitate peer review.¹¹

In order to help prioritize the targets suggested for peer review, a ranking, and associated justifications for peer reviewed items are proposed (Table 2) (*See page 13*).

The timing of peer review ideally should be selected to avoid duplication of efforts that may result in an unsafe environment. Thus, wherever possible, peer review should be performed prior to the “next step” that is dependent on the items being peer reviewed. For example, image segmentation should be done prior to planning in order to avoid re-planning. Treatment plan peer review should be done before initiation of therapy. Failure to do this will result in extra “down stream” work. Further, changes made late in the planning process (or after treatment has been started) often need to be rushed, thus raising safety/quality concerns, especially when using different systems for planning and/or delivery. Frequent re-work can lead to staff fatigue and frustration, with unanticipated consequences.

4.0 Implementing Effective Peer Review

Implementing effective peer review can be challenging. There are often competing demands, and rigid computer/workflow systems that do not readily facilitate or support peer review. Table 3 (*see pages 16-17*) offers a list of potential barriers to effective peer review, possible interventions, and recommendations which may help improve the effectiveness of peer review. The section below offers a more detailed description of examples of suggested improvements and tools that might help make peer review more effective and efficient. The themes raised are potentially more important than the precise methods of implementation.

4.1 Example Process Improvements

a. Management: Effective peer review does not just happen; it must be planned, managed, actively performed, acknowledged as an important activity, and monitored. Facility leaders and managers need to continually assess ongoing peer review activities and implement changes as needed. Clinics should make peer review an integral component of routine practice, rather than an “add on” (Figure 4) (*See page 15*). Standardized systems for defining when, who, and how peer review will be conducted are important to assure that expectations are clear.

b. Allotting necessary resources and time: Leadership need to assure that there are ample resources allotted to support meaningful peer review. Work schedules may need to be adjusted to allow for peer review while enabling work to be completed in a timely fashion. For example, a center with a part-time dosimetrist and a part-time physicist should ensure that enough hours overlap to facilitate their peer review interactions. Ideally, regular meetings where physicians perform peer review on each other’s decisions are needed if dosimetrists are to be able to generate treatment plans in a timely fashion. One would anticipate that if physician peer review is not conducted in a timely manner, there would be need for frequent replanning needs. There is also the concern that weekly peer review done after the start of treatment may be less effective since the barriers for making changes increase once treatment has been started. Further, patient-specific technical issues (eg, problems with setup, imaging, 4-dimensional [4D] data acquisition, gating, etc) are often not adequately discussed or addressed in the regular facility chart rounds due to time limitations. Adequate time needed for peer review should be included in the time-line for patients as they move through the broad chain from consultation, to planning, and to treatment. For example, the treating physicians need to perform their image segmentations in a timely fashion to enable time for peer review prior to dosimetry planning.

FIGURE 4

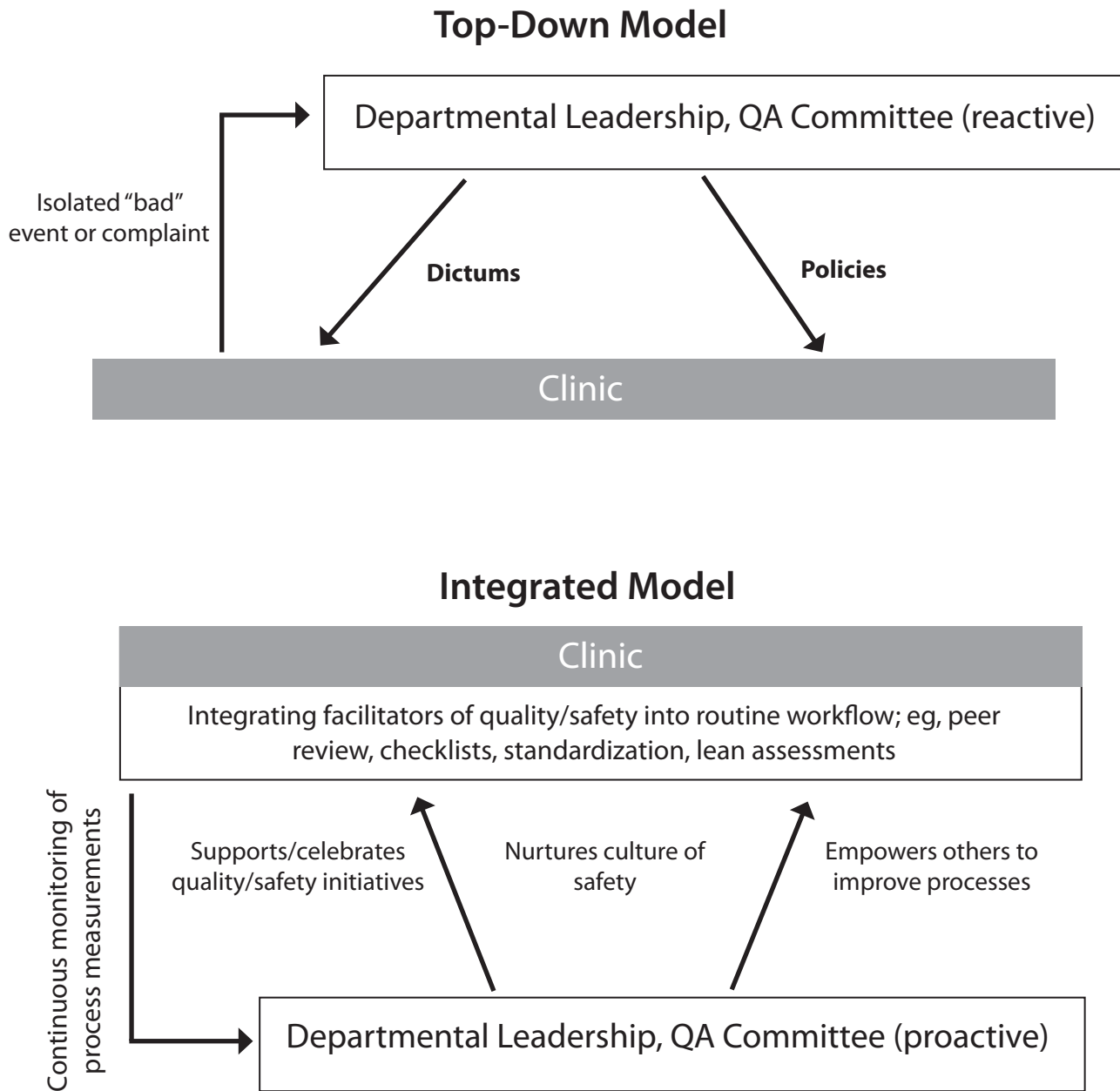


Figure 4: Peer review should be an integral component of a comprehensive QA/safety program.

Top Panel: A “top-down” model of QA has the departmental leadership (and QA committee) largely reactive; eg, policies and dictums are “handed down” to the clinic, often in response to isolated events. **Bottom panel:** Integrated model where departmental leadership and QA committee proactively support and nurture a culture of safety. All staff are encouraged to become engaged in improving operations including peer review. (Adapted with permission from Chera et al;²⁵ and from “Safety Is No Accident” .²⁰)

Table 3. Barriers to Peer Review, Potential Interventions, and Recommendations

Barriers or Challenges to Peer Review Practices	Contributing or Explanatory factors	Potential Process Improvements	Potential Technical Improvements	Key Preliminary Recommendations
<ul style="list-style-type: none"> Insufficient time to include routine peer review in practice Real or perceived lack of time for peer review 	<ul style="list-style-type: none"> Increasing caseload Increasing demands on personnel Critical mass of participants necessary Time required to organize peer review activities 	<ul style="list-style-type: none"> Leadership is needed to provide integrated peer review into clinical practice and support peer review initiatives Identify peer review-dedicated leads or 'champions' Promote staff willingness to participate 	<ul style="list-style-type: none"> Technical enhancements to maximize efficiency of peer review (eg, simultaneous projection of electronic medical record and planning system outputs) Better software tools that integrate peer review into routine processes, and track the peer review process. Better peer review instruments to guide processes 	<ul style="list-style-type: none"> Leadership should embrace peer review as an essential activity, help define key targets for peer review, and implement supportive strategies such as allotting the necessary time Vendors and users must work together to define and create hardware and software tools
<ul style="list-style-type: none"> Key targets of peer review elements not identified Peer review processes poorly defined 	<ul style="list-style-type: none"> Review often focused on administrative requirements (eg, billing, coding, documentation) that are less critical than quality/safety issues 	<ul style="list-style-type: none"> Define critical elements of peer review in specific settings Consider linking peer review activities to CQI models 	<ul style="list-style-type: none"> Electronic or automated checklists to guide presentation and assessment of peer review target elements Electronic monitoring of outcomes of peer review so its efficacy can be monitored 	<ul style="list-style-type: none"> See suggestions in Table 2 ASTRO and AAPM to develop ongoing guidelines regarding prioritizing targets and on the evaluation of effectiveness of peer review (eg, through consensus statements), based on process evaluation and impact on outcomes
<ul style="list-style-type: none"> Increasing treatment complexity 	<ul style="list-style-type: none"> Peer review more challenging when IMRT utilized 	<ul style="list-style-type: none"> Avoid complexity when peer review is not possible 	<ul style="list-style-type: none"> Develop software that enhances ability to peer review; customized for specific context needs 	<ul style="list-style-type: none"> Vendors and users must work together to define and create hardware and software tools
<ul style="list-style-type: none"> Increased planning resources per plan 	<ul style="list-style-type: none"> Reluctance to alter complex (eg, IMRT) plans once created 	<ul style="list-style-type: none"> Implement appropriate timing of peer review elements; eg, decision-to-treat and treatment volumes prior to planning 	<ul style="list-style-type: none"> Develop software that enhances ability to peer review; customized for specific context needs 	<ul style="list-style-type: none"> Peer review of volumes prior to planning if possible
<ul style="list-style-type: none"> Increased complexity of set-up verification 	<ul style="list-style-type: none"> Daily setup verification with IGRT challenging to review 	<ul style="list-style-type: none"> Develop radiation therapist peer review processes 	<ul style="list-style-type: none"> Enhance registration software to facilitate radiation therapist peer review and/or independent checks 	<ul style="list-style-type: none"> Need continued development of objective tools to facilitate setup verification
<ul style="list-style-type: none"> Insufficient physical resources 	<ul style="list-style-type: none"> Lack of adequate meeting space Lack of adequate computers/projectors Other technical needs 	<ul style="list-style-type: none"> Resource reallocation 		<ul style="list-style-type: none"> Consensus statement on the minimal necessary physical resources for effective peer review
<ul style="list-style-type: none"> No guidelines for appropriate documentation of peer review 	<ul style="list-style-type: none"> Uncertainty regarding role in medical record 	<ul style="list-style-type: none"> Develop process guidelines for documentation of peer review activities and their outcomes 	<ul style="list-style-type: none"> Streamline tools to more readily document peer review within existing record and verify systems 	<ul style="list-style-type: none"> Electronic medical records need to be modified so that peer review can be tracked/documentated (eg, annotation)
<ul style="list-style-type: none"> Complex medical decision making regarding modality selection 	<ul style="list-style-type: none"> Combination of radiation therapy with surgery, chemotherapy increasingly common, with more options regarding timing of various treatments 	<ul style="list-style-type: none"> Increase use of multi-disciplinary tumor boards 	<ul style="list-style-type: none"> Technology to facilitate inter-institutional tumor boards Direct links between the EMR and the medical literature to facilitate integration of medical knowledge into decision making 	<ul style="list-style-type: none"> Multimodality tumor boards should be encouraged and embraced
<ul style="list-style-type: none"> RT imaging information is often not available during tumor board 	<ul style="list-style-type: none"> Historical artifact-construct 	<ul style="list-style-type: none"> Conduct tumor board with Radiation Oncology facilities 	<ul style="list-style-type: none"> Better computer integration and remote access to RT planning system images 	<ul style="list-style-type: none"> RT planning software should be compatible across planning software platform and remotely available
<ul style="list-style-type: none"> Staff perceive that they are at risk of punitive actions if errors are disclosed/discovered 		<ul style="list-style-type: none"> Cultural Change 		<ul style="list-style-type: none"> "Just culture"; eg, people who make an honest mistake should not be punished. However, people should be held accountable for failing to participate in peer review activities

Table 3. Barriers to Peer Review, Potential Interventions, and Recommendations (continued)

Barriers or Challenges to Peer-Review Practices	Contributing or Explanatory factors	Potential Process Improvements	Potential Technical Improvements	Key Preliminary Recommendations
<ul style="list-style-type: none"> • ‘Small’ centers without ‘peers’ 		<ul style="list-style-type: none"> • Create partnerships for ‘inter-center’ peer review 	<ul style="list-style-type: none"> • Tools to facilitate remote ‘inter-center’ review • Objective computer-assisted tools for ‘self review’ 	<ul style="list-style-type: none"> • Incorporation of atlases and other clinical care guidelines into the patient management tools to facilitate ‘self-review’ (eg, direct links between planning systems and RTOG anatomy atlases)
<ul style="list-style-type: none"> • Rapid turn-around procedures: eg, brachytherapy, radiosurgery 	<ul style="list-style-type: none"> • The nature of these procedures makes peer review particularly challenging¹¹ • This is concerning as these procedures may have unique challenges that would benefit from peer review 	<ul style="list-style-type: none"> • Leadership can alter work assignments to make this less challenging and enable peers time for real-time review 	<ul style="list-style-type: none"> • Objective computer-assisted tools for ‘self review’ or enable peers the opportunity for ‘remote’ real-time peer review 	
<ul style="list-style-type: none"> • Apathy/skepticism on the part of staff 	<ul style="list-style-type: none"> • “Overload of oversight” 	<ul style="list-style-type: none"> • Develop systems to prospectively assess utility of peer review to enable leadership and staff to determine if their time is being well spent 	<ul style="list-style-type: none"> • Create electronic tools that facilitate this assessment of peer review 	<ul style="list-style-type: none"> • Leadership support for peer review activities

Abbreviations: CQI (Continuous Quality Improvement); ASTRO (American Society for Radiation Oncology); AAPM (American Association of Physicists in Medicine); IMRT (Intensity Modulated Radiation Therapy); IGRT (Image Guided Radiation Therapy); EMR (Electronic Medical Record); RT (Radiation Therapy); RTOG (Radiation Therapy Oncology Group).

c. Facilities: Peer review can be hampered if participants do not have ready access to all necessary information. Meaningful peer review often requires that the planning images, diagnostic images, and electronic medical records (EMRs) be readily accessible. Computers and workspaces should be outfitted to view multiple sources of data concurrently. Multiple projectors with multiple screens may be needed so that groups can review planning images, diagnostic images, and the EMR concurrently. Conference rooms where peer review is conducted need to be large enough to accommodate all of the relevant team members. Dosimetry workspaces need to be large enough so that multiple people can view the planning images concurrently.

d. Creating a collaborative atmosphere: Creating a culture supportive of peer review can be challenging, and is the topic of many publications. In general, this requires leadership at all levels to continually foster, and actively participate in, peer review activities as well as other initiatives focusing on quality improvement.²⁰⁻²²

Team members need to create an open environment where all persons are comfortable being part of the peer review process; both having their work being reviewed by others, and in openly commenting on the work of others. It can be intimidating for junior members of the team to speak out about work done by their superiors. Leadership need to acknowledge this reality and work doubly-hard to create a just culture – where decisions are respectful and there are no punitive actions for active participation in peer review. Participating in peer review efforts should be required and could be motivated by considering such participation during workers’ evaluations. Active participants should be recognized publically as a means to further validate the importance of peer review.

e. Knowing each other’s names: Workers may be more likely to be more comfortable speaking to each other if they know each other’s name. This is current practice in many surgical settings and may facilitate a more open dialogue.²³

f. Minimizing distractions and maintaining clearly-defined roles and expectations: The ability to implement effective peer review in clinical practice might be hindered by competing demands and distractions. Procedures and work assignments should be adjusted to enable staff the adequate time and focus to attend to peer review activities. For example, interruptions of the therapy staff during the critical pre-treatment setup should be minimized, perhaps even limited to emergencies (eg, re-routing phones to prevent phone interruptions), and access to common tempting distractions (eg, some internet content) might also be restricted. The intention is not to micromanage staff, but rather encourage institutions to define their own policies to minimize distractions and thereby enhance patient safety (which includes performing peer review activities). Clearly defined roles and responsibilities for the different therapists working together on a machine reduces opportunities for miscommunication between therapy staff and may prevent the unintended omission of a peer review action (eg, “I thought that someone else double checked that field.”). This is particularly important in situations where staff are hurried. For example, it is just when the staff are being asked to “fit in that emergency inpatient”, that there is a human tendency to cut corners and where adherence to well-defined procedures is especially important. Non-emergent ‘urgencies’ (eg, replans due to adjustments to image segmentations) should be minimized, and when they are necessary, ample time for the necessary peer review and QA procedures should be maintained. QA committees may want to monitor the frequency of such events.

4.2 Example Technological Improvements

This section recommends a number of changes in software and other technologies that the vendors should consider since they may help improve the efficiency, effectiveness, and/or usefulness of various peer review activities.

a. Integration of peer review tools into our routine workflow (eg, within treatment planning/management systems): Implementation and management of peer review activities would benefit from a way to easily track what peer review steps have been taken within the patient’s EMR. A clinic/user should have the ability to customize a checklist for their site. The software should prompt the user as to what quality assurance steps have been taken, and record who has signed off on the different tasks. Logic tools can be incorporated into such a tool with user-specified hard stops (eg, certain patients [complex, curative, IMRT, SBRT] cannot commence treatment until peer review is complete). There would need to be the option to accommodate some of these hard stops for emergent cases, etc, along with a track-

ing mechanism to assure that this bypass was not being abused and prompts to assure subsequent peer review. It might be possible to automatically verify the integrity of a treatment plan.²⁴

b. Tools to streamline peer review of target doses/prescriptions: Today’s EMRs contain detailed information regarding patient stage, tumor size, etc. Treatment guidelines exist for many tumor types. Clinician decision support tools can be created (eg, within the treatment management systems) to verify consistency between the clinical information, the chosen protocol, and the planned treatment prescription and/or technique. For example, are the prescribed doses consistent with guidelines? Clinics should have the option to customize these protocols, standards, and the implementation of check procedures to their own specifications. In some situations, the ability to select or use various national/international guidelines, protocols, or procedures can be valuable.

c. Tools to assist peer review of normal tissue exposures: Consensus dose/volume/outcome predictions exist for several normal tissues. Software could automatically provide the user with complication rates (or other plan quality metrics) predicted to result from the proposed plan (eg, based on the relevant dose volume histograms [DVHs] and other factors). Of course, this assumes that the images have been appropriately segmented, and that the reference dose/volume/outcome data are applicable to the particular patient. Nevertheless, this might be a powerful approach to at least alert the physician and planners to possible unforeseen risks. Care should be taken when using such automated tools for clinical decisions.

d. Tools to facilitate peer review of segmented anatomy: Anatomic atlases define “typical” anatomy. Tools can be created that compare segmented planning images to a series of reference images to help the planner or reviewer identify areas of unusual segmentation that should be verified or discussed as part of the peer review process.

e. Inter-center connectivity: Small centers with a limited number of staff likely find peer review to be challenging due to the “lack of peers.” Systems that enable workers at different centers to readily review each other’s work would certainly help in this regard. For example, Chartrounds (www.chartrounds.com) is a virtual networking site supported by the American Society of Clinical Oncology (ASCO) Cancer Foundation Improving Cancer Care Grant, (PI Dr. Patricia Hardenbergh, a solo-practitioner), funded by Susan G. Komen for the Cure, that provides the opportunity for such peer review interactions to occur. It is recommended that vendors

work to provide products that make the technical aspects of this interaction more accessible, and that ASTRO and other organizations work to organize collaborative efforts to implement this “peer review-at-a-distance” paradigm. Another possible approach is to provide continuing medical education (CME) credits to motivate this kind of help between centers, since peer review discussion of the pros and cons of various approaches is likely to be an effective continuing education method. We believe that the creation of such peer review partnerships is a potentially useful approach, especially for smaller practices. Nevertheless, we also acknowledge that there are major barriers to such an implementation (eg, HIPAA, relationships with neighboring/competing centers). As a field, we should try to create systems to reduce these barriers to facilitate such inter-center peer review.

4.3 Peer Review in the Context of Evolving Roles

The changing practice of radiation oncology is leading to modification of traditional tasks ascribed to each team member. Table 4 (*see page 20*) illustrates some of these changes in tasks, and how this might have some implications for peer review.

4.4 Peer Review in the Context of Education

Redefining/expanding peer review will be an evolutionary process. Current practitioners will need to have instruction in peer review. Recommendations include the following:

Internal Education

- 1) Peer review methods should be included in the educational curriculum of radiation oncology residents, medical physicists, medical dosimetrists, and radiation therapists. This instruction can be incorporated into existing coursework or be presented as a stand-alone class on quality and safety. Such classroom instruction would supplement the “hands on” observations and efforts in the clinic.
- 2) Computer-based educational software may be helpful to train current practitioners to better understand the concepts and opportunities of clinical peer review. This type of computer-based learning can be asynchronous (outside the constraints of time and place) and should offer continuing education credits for the user. Because peer review methods were not included in the standard education curriculum of current physicians, physicists, dosimetrists, or therapists practicing radiation therapy, it is important to offer this type of computer-based education. It is important that we address the concern that we

are asking radiation oncology facility leaders and staff to accept peer review as an important patient safety tool, even though they may have limited educational background in its power and use.

- 3) The educational development of peer review terminology to enhance its standard usage, as is often practiced in other industrial sectors, as part of the development of any new process or product usage.

External Education

- 4) Vendors: Professional society leaders should work with vendors to educate them about the direction and vision of radiation therapy clinical practice, its enhanced need for patient safety, and the needed development, implementation, and evaluation of clinical peer review tools. Vendors should understand that the viability of future products will be judged, at least in part, on the safety features and tools for effective peer review that are incorporated into the product.
- 5) Insurers/Centers for Medicare and Medicaid Services (CMS): It is important for insurers and CMS to better understand the need for peer review within radiation oncology. This is an excellent opportunity to develop relationships with insurers and payors to help them better understand how new and improved processes, such as the activities outlined in this peer review paper, are used to enhance quality and patient safety.
- 6) Public: Patients and the broader society are increasingly aware of the risks of modern medicine. We have an opportunity to share with all of our stakeholders the importance of peer review, and its role in our efforts to enhance patient safety. Since peer review can take time, patients may be more understanding of delays in initiating therapy if they understand that part of the delay is due to routine peer review and other safety efforts. Further, one can imagine an educated patient asking his care team if “my case has gone through peer review.” In the eyes of our stakeholders, developing and implementing systematic peer review models will help improve the perception and reality of a culture of safety within radiation oncology.

5.0 Discussion

Peer review is time consuming and has sometimes been seen as an “extra step.” In some practices, a change in attitude is needed to alter the culture so peer review is seen as a routine component of clinical practice. This requires that leadership openly support these activities. The physical plant, workflow, and processes of care

Table 4: The Potential Impact of Evolving Roles on Modifications/Improvements to Peer Review

Team Member	Evolving Responsibilities	Potential Impact on Peer Review
Physician	<ul style="list-style-type: none"> • Team leader for patient safety • Increasing complexity requires additional coordination of care with multidisciplinary team 	<ul style="list-style-type: none"> • Oversee the utility of peer review • Make management decisions allowing adequate time, resources for peer review • Relinquish some autonomy to others • Motivate others to embrace peer review • Maintain a just culture
Nurse Practitioners & Physician Assistants	<ul style="list-style-type: none"> • Increasingly taking on responsibilities and assisting in multidisciplinary coordination 	<ul style="list-style-type: none"> • May play an increased role in peer review of “medical” decisions
Physicist	<ul style="list-style-type: none"> • Incorporate technological innovations to improve patient/staff safety • Assess safety of treatment processes, (eg, with statistic processes, failure mode analysis, fault trees, etc) 	<ul style="list-style-type: none"> • Provide peer review for IGRT decisions • Monitor utility of peer review for most technical aspects of care
Dosimetrist	<ul style="list-style-type: none"> • Image cataloging/manipulation (eg, fusion/registration/segmentation) • Assist in IMRT/IGRT equipment QA • More complex treatment plans • Deformable registration/adaptive radiation therapy 	<ul style="list-style-type: none"> • Closer interactions with therapists to assure accurate implementation of complex treatments • Adequate instructions in anatomy • Proper utilization of emerging imaging/segmentation tools • “Advanced Practice” Dosimetrist
Therapist	<ul style="list-style-type: none"> • Assessment of 2D/3D images to make decisions concerning patient treatment/motion/alignment (eg, daily IGRT positioning decisions) 	<ul style="list-style-type: none"> • Coordinate with physicians who historically were largely responsible for review of 3D images • Safe and proper use of additional imaging and treatment delivery systems
Nurse	<ul style="list-style-type: none"> • Assist in multidisciplinary coordination 	<ul style="list-style-type: none"> • Facilitates real-time peer review in the clinic (coordinates activities with multiple providers)
Administrator	<ul style="list-style-type: none"> • Support patient safety program 	<ul style="list-style-type: none"> • Increased understanding needed of the evolving roles and associated implications for staffing and resource allocation
IT Specialist	<ul style="list-style-type: none"> • Connectivity among different systems • Failure mode analysis • Data archiving/recovery 	<ul style="list-style-type: none"> • Help create software tools to facilitate peer review • Review resources needed • IT needs to interact and take direction from physics in order to assure safe IT work • Assure vendor interoperability needed for peer review

*eg, Software that compares a proposed plan to a library of plans with “similar” anatomy.

Note: The evolving responsibilities, and their pace of change, will likely vary by institution and availability of new technologies.

Abbreviations: IGRT (Image Guided Radiation Therapy); IMRT (Intensity Modulated Radiation Therapy); QA (Quality Assurance); 2D (2-dimensional); 3D (3-dimensional); IT (Information Technology).

need to be structured to make peer review possible, and with the least amount of “extra work.” The software, tools, and environment need to be conducive to efficient peer review.

Embracing a culture of peer review can provide benefits beyond the explicit peer review decisions. Members of the healthcare team involved in peer review may feel empowered to increase their sphere of influence. They may be more likely to suggest improvements in operations that benefit all. Broadly embracing the concept of peer review helps to create an environment where questions can be asked, and where all team members are valued and respected. This can lead to a more collegial and cohesive team, with greater dedication to cooperation and teamwork, and the overall work environment can be improved, increasing worker and patient satisfaction.

Scheduled peer review meetings serve the function of bringing the facility together on a regular basis, further helping to build a sense of community and mutual respect. In addition, regular peer review meetings can be an important educational activity for trainees.¹¹

The incorporation of peer review into routine practice requires the concerted efforts of many people. Peer review is a powerful tool that enhances radiation oncology patient safety and practice improvement, and its utility can be applied more broadly within radiation oncology processes.

6.0 Summary of General Recommendations

1. Peer review of important non-technical decisions has the potential to improve the quality of radiation therapy that patients receive. Thus, it should be embraced by leadership and staff and be considered part of the standard practice.
2. Leadership need to empower the staff to be involved in peer review activities (eg, facilitate and support their involvement) and provide the necessary infrastructure for efficient and effective peer review (eg, adequate space, image display capabilities, access to electronic records, support staff to help monitor and facilitate review, software tools).
3. Peer review should be conducted in the context of an open and just culture, such that staff do not feel threatened by the peer review process. For example, people who are found to have made an honest mistake should not face punitive measures. On the other hand, people should be held accountable for failing to participate in peer review activities.
4. Clear expectations for the “content” and the conduct of peer review efforts (eg, the what, when, where, and how) are necessary. Among the many targets relevant to

improving safety and quality with peer review methods, the most obvious high priority targets include the following:

- a. **Physician:** Physicians are indicated in 5 of the 7 prioritized items for peer review. In descending order, they include the following: Level 1: target definition; Level 2: decision to include radiation as part of treatment, planning directive; Level 3: general radiation treatment approach, normal tissue image (Table 2) (see page 13).
 - b. **Dosimetrist:** Level 2: technical plan quality (Table 2).
 - c. **Therapists:** The first day of treatment delivery is considered Level 1, high priority peer review for radiation therapists, especially in curative cases, IMRT, and SBRT cases where there is no independent assessment of the targeted volume. Other treatment days are considered Level 2, next highest priority (Table 2).
 - d. **Physicists:** Level 1 for pre-treatment setup verification for complex cases (eg, SBRT). Level 2: technical plan quality for treatments in general (Table 2).
5. The specific goals and targets of peer review should be clearly specified, and the results of each peer review effort ideally should be tracked. Creative ways to actively monitor the clinical utility of peer review are needed to reassure staff that their time is well spent and to identify opportunities for improvement.
 6. Users and vendors should collaborate to define and create software and hardware tools that can help make peer review more efficient and effective and to keep track of these peer review activities (eg, providing the ability for annotation in the EMR).
 7. For small practices, where peer review is particularly challenging, we encourage the creation of peer review relationships among physicians from separate (perhaps distant) practices.
 8. The principles of peer review should be included in the curriculum in educational programs. Students should be included as participants in (or at least observers of) peer review as it can be educational, promotes a culture of respectful questioning (ie, students observe professionals questioning each other), and reinforces the role and utility of peer review as part of routine clinical practice.
Developing a successful comprehensive peer review program requires the concerted activities of many

people. Example actions central to the peer review mission are outlined in Table 5, for leadership, staff, and vendors, who can all help facilitate improved safety and quality through more effective peer review.

7.0 Conclusions

Peer review is an essential component of a broad safety/QA program. Peer review is one of the most effective means for assuring the quality of qualitative, and potentially controversial, decisions in radiation oncology. While radiation oncology has a long tradition of using peer review, advances in modern radiation oncology require the extension of the conscious use of peer review throughout evaluation, treatment planning and treatment delivery. This report summarizes many of the areas throughout radiation therapy that may benefit from the application of peer review, as we work to improve the quality and safety of the radiation oncology process for each patient. Each radiation oncology facility should evaluate the issues raised, and develop improved ways to apply the concept of peer review to

its individual process and workflow. This might consist of a daily multi-disciplinary (eg, physicians, dosimetrists, physicists, therapists) meeting to review patients being considered for, or undergoing planning for, radiation therapy (eg, assess intention to treat and target delineation), as well as meetings to review patients already under treatment (eg, assess adequacy of image guidance).

National organizations have a role to play in the application of these ideas, as they can evaluate, recommend, and facilitate specific approaches that should be applied across the range of radiation oncology facilities and practices, once those approaches are shown to be effective.

This report is intended to clarify and broaden the understanding of radiation oncology professionals regarding the meaning, roles, benefits, and targets for peer review as a routine quality assurance tool. It is hoped that this work will be a catalyst for further investigation, development, and study of the efficacy of peer review techniques and how those efforts can help improve the safety and quality of our treatments.

Table 5: Example Actions Central to Facilitating Peer Review

Leadership/Management	Staff	Vendors
Embrace just culture	Open minded	Provide software tools to keep track of various patient-specific peer review activities (eg, support checklists that track peer review activities and annotation of the EMR)
Set example	Proactive, willing to participate actively	Provide software that facilitates various steps of peer review (eg, make it easier to review DVHs and incorporate peer review tools into planning systems)
Applaud peer review activities	Create peer pressure to support open peer review	Provide software that is flexible enough to conform to the needs of individual clinics
Address issues in a systematic manner		Provide means to determine where peer review can be enhanced
Make time for people to be involved in peer review activities		
Educate the team about the role/utility of peer review		
Actively monitor the effectiveness of ongoing peer review activities		

Abbreviations: EMR (Electronic Medical Record); DVH (Dose Volume Histogram).

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