Development of a Comprehensive, Contour-Based, Peer Review Workflow at a Community Proton Center

Benjamin T. Cooper, MD[1]; Anuj Goenka, MD[2]; Kevin Sine, CMD[3]; Jae Y. Lee, MD, PhD[3,4]; Brian H. Chon, MD[3]; Henry K. Tsai, MD[3,4]; Eugen B. Hug, MD[3]; Hiral P. Fontanilla, MD[4]

[1]Department of Radiation Oncology, NYU Langone Health, New York, NY, USA
[2]Department of Radiation Medicine, Northwell Health, Zucker School of Medicine at Hofstra/Northwell, Lake Success, NY, USA
[3]Procure Proton Therapy Center, Somerset, NJ, USA
[4]Princeton Radiation Oncology, Princeton, NJ, USA

Abstract

Purpose: Quality assurance and continuing quality improvement are integral parts of any radiation oncology practice. With increasingly conformal radiation treatments, it has become critical to focus on every slice of the target contour to ensure adequate tumor coverage and optimal normal tissue sparing. Proton therapy centers open internationally with increasing frequency, and radiation oncologists with varying degrees of subspecialization apply proton therapy in daily practice. Precise treatment with proton therapy allows us to limit toxicity but requires in-depth knowledge of the unique properties of proton beam delivery. To address this need at our proton therapy center, we developed a comprehensive peer review program to help improve the quality of care that we were providing for our patients.

Materials and Methods: We implemented a policy of comprehensive peer review for all patients treated at our community proton facility starting in January 2013. Peer review begins at the time of referral with prospective cases being reviewed for appropriateness for proton therapy at daily rounds. There is then biweekly review of target contouring and treatment plans.

Results: During a 6-month period from June 2013 to November 2013, a total of 223 new patients were treated. Documentation of peer review at chart rounds was completed for 222 of the 223 patients (99.6%). An average of 10.7 cases were reviewed in each biweekly chart rounds session, with a total of 560 case presentations. The average time required for contour review was 145 seconds (±71 seconds) and plan review was 120 seconds (±64 seconds). Modifications were suggested for 21 patients (7.9%) during contour review and for 19 patients (6.4%) during treatment plan review. An average of 4 physicians were present at each session.

Conclusions: We demonstrated that the implementation of a comprehensive, prospective peer review program is feasible in the community setting. This article can serve as a framework for future quality assurance programs.

Keywords: proton therapy; quality improvement; peer review; contour; radiation; radiation therapy

Submitted 26 Mar 2019
Accepted 23 Apr 2020
Published 22 June 2020

Corresponding Author:
Benjamin T. Cooper, MD
Department of Radiation Oncology
NYU Langone Health
160 E. 34th Street
New York, NY 10016, USA
Phone: +1 (212) 731-5003
Fax: +1 (212) 731-5512
benjamin.cooper@nyumc.org

Original Article

DOI
10.14338/IJPT-19-00059.1

Copyright
2020 The Author(s)

Distributed under
Creative Commons CC-BY

OPEN ACCESS

http://theijpt.org

Introduction

Quality assurance (QA) and continuing quality improvement are integral parts of any medical practice and have become routine in radiation oncology [1]. Quality assurance in radiation oncology can apply to all areas of the department, including patient decision to treat, target delineation, treatment planning, and treatment delivery. One aspect of a comprehensive QA program is peer review, where experts in the same field provide feedback on one another's work and provide constructive criticism. In radiation oncology, physician peer review usually takes the form of "chart rounds" consisting of some mix of contour review, radiation dose prescription scrutiny, and treatment plan evaluation. This type of peer review has led to changes in clinical care in approximately 1 in 9 radiation plans, further emphasizing its importance [2].

The American Society for Radiation Oncology (ASTRO) has published a white paper on peer review intended to clarify the most important components of an effective QA program. They ordered items by priority, with target definition and patient setup on day 1 given the highest priority [3]. While target definition or contouring is of upmost importance, only a minority of cases undergo peer review before treatment planning begins, with only 45% of radiation oncologists performing any separate contour review [4]. With increasingly conformal radiation treatments, it has become critical to focus on every slice of the target contour to ensure adequate tumor coverage and optimal normal tissue sparing. Precise treatment with proton therapy and intensity-modulated radiation therapy (IMRT) allows us to limit toxicity, but requires in-depth knowledge of axial computed tomography anatomy, tumor patterns of spread, and target volume delineation. Early experiences with IMRT demonstrated the importance of contour accuracy with marginal misses occurring in areas that would normally be included in a 2D plan [5, 6]. The problems, previously highlighted in patients treated with IMRT, have the potential to be magnified with proton therapy, where nontarget tissue distal to the Bragg peak can receive little or no radiation dose.

To address this need at our proton therapy center, we developed a comprehensive peer review program to help improve the quality of care that we were providing for our patients. In this article we describe our experience developing this program, something that has not been reported for a community-based proton facility to our knowledge. This can serve as a model for the institution of similar programs in the community setting to further promote a culture of safety and quality.

Materials and Methods

This study was reviewed by our institutional research infrastructure and was determined to be exempt from institutional review board approval owing to the primary goal being quality improvement and assurance.

We implemented a policy of comprehensive peer review for all patients treated at our community proton facility starting in January 2013. Peer review begins at the time of referral with prospective cases being reviewed for appropriateness for proton therapy at daily rounds. There is then biweekly, separate review of target contouring and treatment plans every Tuesday and Thursday at noon. In contrast to traditional chart rounds that evaluate approved radiation treatment plans, we review contours for each case prospectively, before physics planning takes place, and again for review of treatment plans before the patient starts treatment. Cases are presented at biweekly Web-based chart rounds for review of the target and normal tissue contours, immobilization, treatment dose, and discussion of treatment planning considerations specific to proton therapy. The Web-based platform WebEx from Cisco Systems Inc (Service Version WBS32, San Jose, California) is used to facilitate attendance and input of physicians working at off-site facilities. All team members are encouraged to attend and a minimum of 2 physicians are required to be present at each session. Practice policy dictated that no patient appointments be scheduled during the 2 hours a week in which chart rounds were held to facilitate maximum attendance.

The list of patient cases to be presented is generated by the dosimetry group as based on the available treatment planning task list and is distributed to the practice physicians before conference. For each patient, the physician presents the relevant clinical history and physical exam findings, imaging, and planned prescription dose. Gross tumor volumes, clinical target volumes, and organ at risk contours are reviewed on each axial slice with the appropriately fused relevant diagnostic images for both the primary plan and any associated cone-down plans. Treatment planning considerations are also discussed including selection of beam angles, treatment delivery room (fixed beam, incline beam, or gantry), and passive scatter versus pencil beam scanning. To help streamline the logistics of treatment planning and avoid unanticipated patient start delays, we discuss the length of time needed for treatment planning and specific treatment planning goals. We also included radiation therapists to discuss pertinent treatment setup and immobilization concerns in a prospective manner.

The cases are presented again after the completion of treatment planning, before the start of treatment, for review of the treatment plan with a focus on dose distribution, normal tissue constraints, robustness of plan, need for replanning or resimulation during treatment, and anticipated toxicity. Beam approach and beam weighting are discussed at this time with

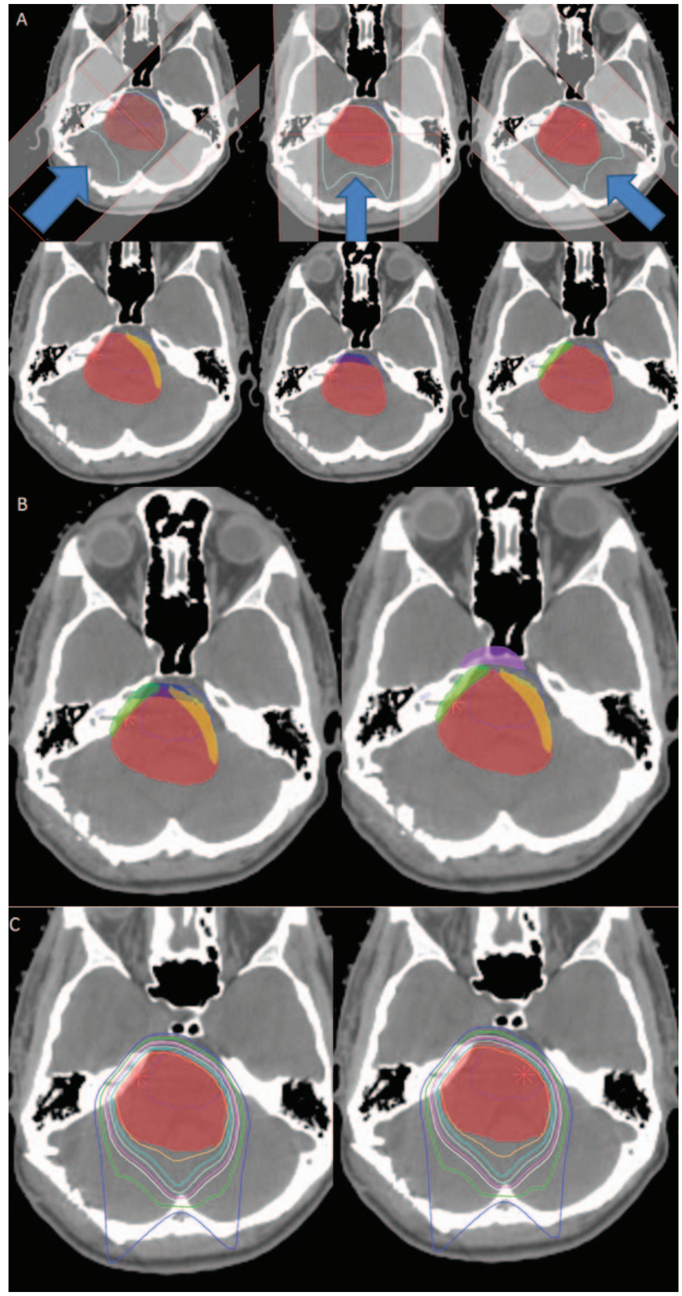

Figure 1. An example of an end-of-range issue that was identified in QA and the plan was adjusted. A 3-field (blue arrows indicate beam direction) configuration for the treatment of ependymoma, showing the area of high LET at the end of the beam's range (A). An area of overlap between high LET areas could result in brainstem toxicity (B, left) but can be avoided by intentionally overranging the PA field (B, right). The overall dosimetry between the initial plan (C, left) and the intentionally overranged plan (C, right). Abbreviations: LET, linear energy transfer; PA, Posterior Anterior; QA, quality assurance.

special attention to challenges specific to proton therapy such as end of range and robustness of plan. Isodose lines are reviewed on each axial slice to add spatial information lacking in dose-volume histograms. Proton-specific issues that are discussed include the following: (1) robustness of beams to range uncertainty; for example, if 2 beams are ranging into one another, would there be an unacceptable hot spot created; (2) review of potential high linear energy transfer (LET) overlap regions where proton beams terminate and ensuring that this region is not in an organ at risk (**Figure 1**); (3) beam angle selection to best spare normal tissue (**Figure 2**); and (4) identifying the effect of variable filling structures, such as nasal cavities, and ordering routine QA computed tomography scans to address risks associated with ranging into downstream structures (eg, brainstem through the nasal cavity).

Our center has developed standardized dose constraints for each disease site to guide initial treatment planning. The treatment team again has the opportunity to discuss possible toxicity and management, or anticipate the need to re-plan due to changes in patient anatomy (eg, significant weight loss). Recommendations made at any time in the review process are documented in a log by a dosimetrist assigned to QA and distributed in an updated patient list to the practice radiation

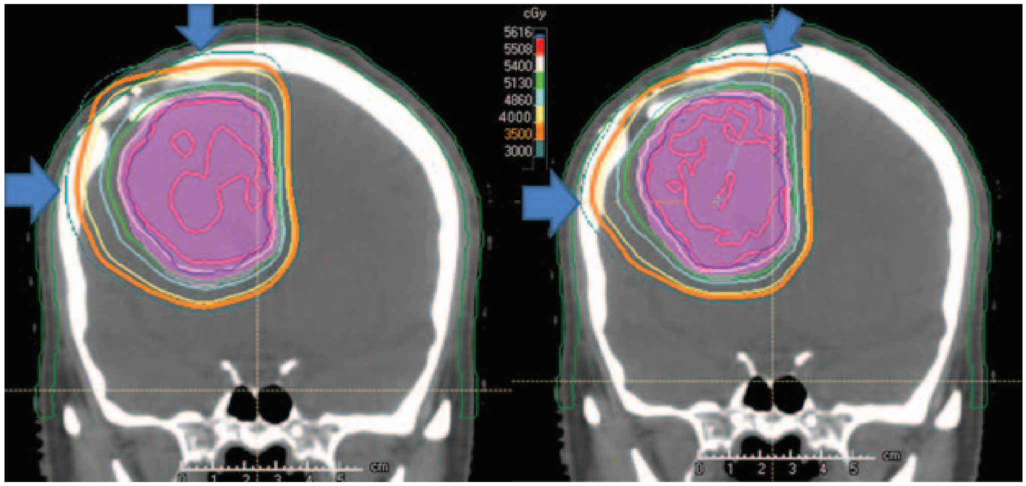

Figure 2. A patient treated for high-grade glioma with the vertex beam (blue arrow) adjusted to avoid beam overlap at the scalp. Patient was seen 6 months following radiation therapy and her alopecia has resolved.

oncologists. Emails are also sent directly to the treating physician detailing any changes that were recommended. Any patient case requiring changes to the contours or plan will be presented again at the following QA session.

Results

During a 6-month period from June 2013 to December 2013, a total of 223 new patients were treated (**Table**), and documentation of peer review at chart rounds was completed for 222 of the 223 patients (99.6%). An average of 10.7 cases were reviewed in each biweekly chart rounds session, with a total of 560 case presentations. The average time required for contour review was 145 seconds (standard deviation, 71 seconds) and plan review was 120 seconds (standard deviation, 64 seconds). Modifications were suggested for 21 patients (7.9%) during contour review and for 19 patients (6.4%) during treatment plan review. On average 4 physicians were present at each session. Twenty-three patients (7.8%) had the contours and plans reviewed at the same time (instead of contour review before planning). Changes were typically related to target and normal anatomy contouring, beam angle selection, and end-of-range issues.

Discussion

We demonstrated that implementation of a comprehensive, prospective peer review program is feasible in the community setting. All but 1 of the patient cases were presented and for most patients (92.2%), contours were reviewed before planning. Implementation of this program led to changes in 7.9% and 6.4% of the contour and plan reviews, which is on par with previously presented QA projects [7, 8]. Even among experts, peer review can alter target delineation. In a study conducted at MD Anderson Cancer Center, 134 consecutive patients with head and neck cancer underwent physical exam, fiberoptic endoscopy, and review of relevant diagnostic images by multiple radiation oncologists subspecializing in head and neck cancer after the treating physician had completed contouring. Treatment modifications that were considered major and could affect outcome or toxicity occurred 11% of the time, emphasizing the importance of careful contour review at a high-volume academic center with disease site subspecialization [9]. Their experience was recently updated, and comprehensive peer review planning led to major changes in one third of the study population [10]. Contouring differences have also been

Table. Summary of cases presented at quality assurance conference.

	No. of cases (%)
Patients reviewed/treated	222/223 (99.6)
Presentations	560
Average number of cases per session	10.7
Contours modified/reviewed	21/266 (7.9)
Plans modified/reviewed	19/294 (6.4)
Contours and plan	23 (7.8)

highlighted in lung, breast, sarcoma, and prostate cancer target delineation, further stressing the importance of careful peer review [11–14]. Contour variability has even been quantified in cancer patients treated with palliative intent, yet specific contour review is not routinely done in many radiation oncology centers [15].

In another study, Matuszak et al [16] reported on preplanning contour peer review for patients receiving Stereotactic Body Radiation Therapy (SBRT) treatment and found that of 513 patients, 22.6% had at least 1 change made. Target volumes were changed between 5% and 8% of the time. They also found that fewer changes were recommended when the treating oncologists had more SBRT experience, suggesting that peer review is even more important in centers with less experience with complex treatments.

Our peer review process can serve as an important model for development of a comprehensive program in the community setting, for photon and proton centers. It addresses some of the most common challenges to the routine adoption of a comprehensive peer review program in the community. The use of a WebEx platform served as a sufficient videoconferencing platform, an obstacle to peer review that has been cited in physician surveys [17]. Furthermore, our Web-based platform allows for chart rounds to be performed at sites with only 1 physician on site and also provides flexibility for physician time. When compared to a more common weekly schedule, biweekly conferences optimize presentation of contours and plans prospectively, without large delays in patient starts.

The need for enhanced focus on quality improvement is well known, and ASTRO has previously commissioned and published a white paper discussing the critical components of a successful peer review program [3]. One of the main issues discussed in that report was the importance of target definition audit. Cox et al [18] highlighted the importance of contour review, which led to improved efficiency and decreased treatment delays as their contour review program matured over a 6-month period.

Quality improvement is equally important in both academic and community radiation treatment centers, and with expanding health care networks the need for Web-based peer review conferencing is growing [19]. Having a Web-based platform allows for more flexibility with scheduling, as it is less reliant on multiple physicians being physically present. This also allows for cooperation between radiation oncology departments that may be otherwise separated physically. Thaker et al [20] have previously reported the utility of a case-based, peer review process that enabled remote evaluation of quality of care in the community affiliates of a large academic cancer network. This study identified discordance in the care of 17% of audited patients with regard to institutional and national standards.

As IMRT has made target delineation review even more important than in the 3D-Conformal Radiation Therapy era, it is possible that similarly, proton radiation therapy may further increase the importance of prospective review of the contour given the greater conformality this technique offers. Additionally, while the medical applications of proton particle therapy have been theorized since 1946 [21], the number of active proton centers has expanded rapidly in the United States from 2 in 2003 to 22 in 2016 [22]. This rapid expansion, coupled with lack of access to proton therapy training at most radiation oncology residency programs, can lead to underappreciation of the radiation planning challenges specific to proton therapy, such as plan robustness and end-of-range issues.

We found peer review valuable, with changes made as a result of the conference directly affecting patient care to mitigate toxicity with subtle beam changes that do not compromise tumor coverage. The 2 cases presented highlight how alternative beam range selection and beam angles can possibly decrease 2 concerns with cranial proton therapy: brainstem toxicity and permanent alopecia. **Figure 1** highlights the case of a pediatric patient with an ependymoma and overlap of the possible high LET regions at the end of a beam's range. By intentionally overranging the Posterior-Anterior beam, the high LET region is shifted anteriorly with no appreciable change to the overall dose distribution. **Figure 2** highlights an alternative beam angle to decrease beam overlap and reduce scalp dose without significantly increasing the brain dose. This young woman's alopecia has completely resolved 4 months after proton therapy. Further studies are needed to see if clinical outcomes vary more with proton treatment, dependent on the methods of peer review used at that respective center.

Proton therapy is gaining increasing acceptance. As the indications grow to include common malignancies and as manufacturers offer single- or 2-room facilities, more proton centers are being built and operated each year (www.ptcog.org). Radiation oncologists with varying degrees of practical experience are entering the field of proton therapy. Proton therapy is a highly complex subspecialty, requiring knowledge beyond the curriculum of residency training specifically in light of the routine application of spot scanning delivery technique. In reality, most radiation oncologists attend training seminars on particle therapy, but few will have the opportunity to immerse themselves in practical fellowships at proton centers. A well-organized peer review, as delineated in this article, serves not only as a QA tool to elevate levels of patient care, but also as an important tool for continued information exchange between the radiation oncologists. Today's technology does not require physical attendance, thus affording the opportunity to engage with off-site physicians.

In summary, it is our hope that by demonstrating the feasibility of developing a comprehensive contour-based, peer review process at a community proton facility, other centers, both in the community or at a large academic institution, could use this experience as a framework to develop a peer review program that addresses all of the challenges and potential pitfalls of proton radiation therapy.

ADDITIONAL INFORMATION AND DECLARATIONS

Conflicts of Interest: The authors have no relevant conflicts of interest to disclose.
Funding: The authors have no funding to disclose.
Ethical Approval: This study was reviewed by the authors' institutional research infrastructure and was determined to be exempt from IRB approval.

References

1. Maquilan GM, Tsai HK, Fontanilla HP. Individual patient-based peer review for photon and proton therapy. In: Dicker AP, Williams TR, Ford EC, eds. *Quality and Safety in Radiation Oncology*. New York, NY: DemosMedical; 2016:163–7.
2. Brunskill K, Nguyen TK, Boldt RG, Louie AV, Warner A, Marks LB, Palma DA. Does peer review of radiation plans affect clinical care: a systematic review of the literature. *Int J Radiat Oncol Biol Phys*. 2017;97:27–34.
3. Marks LB, Adams RD, Pawlicki T, Blumberg AL, Hoopes D, Brundage MD, Fraass BA. Enhancing the role of case-oriented peer review to improve quality and safety in radiation oncology: executive summary. *Pract Radiat Oncol*. 2013;3:149–56.
4. Hoopes DJ, Johnstone PA, Chapin PS, Kabban CM, Lee WR, Chen AB, Fraass BA, Skinner WJ, Marks LB. Practice patterns for peer review in radiation oncology. *Pract Radiat Oncol*. 2015;5:32–8.
5. Eisbruch A, Marsh LH, Dawson LA, Bradford CR, Teknos TN, Chepeha DB, Worden FP, Urba S, Lin A, Schipper MJ, Wolf GT. Recurrences near base of skull after IMRT for head-and-neck cancer: implications for target delineation in high neck and for parotid gland sparing. *Int J Radiat Oncol Biol Phys*. 2004;59:28–42.
6. Eisbruch A, Foote RL, O'Sullivan B, Beitler JJ, Vikram B. Intensity-modulated radiation therapy for head and neck cancer: emphasis on the selection and delineation of the targets. *Semin Radiat Oncol*. 2002;12:238–49.
7. Brundage MD, Dixon PF, Mackillop WJ, Shelley WE, Hayter CR, Paszat LF, Youssef YM, Robins JM, McNamee A, Cornell A. A real-time audit of radiation therapy in a regional cancer center. *Int J Radiat Oncol Biol Phys*. 1999;43:115–24.
8. Boxer M, Forstner D, Kneebone A, Delaney G, Koh ES, Fuller M, Kaadan N. Impact of a real-time peer review audit on patient management in a radiation oncology department. *J Med Imaging Radiat Oncol*. 2009;53:405–11.
9. Rosenthal DI, Asper JA, Barker JL Jr, Garden AS, Chao KS, Morrison WH, Weber RS, Ang KK. Importance of patient examination to clinical quality assurance in head and neck radiation oncology. *Head Neck*. 2006;28:967–73.
10. Cardenas CE, Mohamed ASR, Tao R, Wong AJR, Awan MJ, Kuruvila S, Aristophanous M, Gunn GB, Phan J, Beadle BM, Frank SJ, Garden AS, Morrison WH, Fuller CD, Rosenthal DI. Prospective qualitative and quantitative analysis of real-time peer review quality assurance rounds incorporating direct physical examination for head and neck cancer radiation therapy. *Int J Radiat Oncol Biol Phys*. 2017;98:532–40.
11. Valicenti RK, Sweet JW, Hauck WW, Hudes RS, Lee T, Dicker AP, Waterman FM, Anne PR, Corn BW, Galvin JM. Variation of clinical target volume definition in three-dimensional conformal radiation therapy for prostate cancer. *Int J Radiat Oncol Biol Phys*. 1999;44:931–5.
12. Major T, Gutierrez C, Guix B, Mozsa E, Hannoun-Levi JM, Lossl K, Niehoff P, Resch A, van Limbergen E, Polgar C. Interobserver variations of target volume delineation in multicatheter partial breast brachytherapy after open cavity surgery. *Brachytherapy*. 2015;14:925–32.
13. Genovesi D, Ausili Cefaro G, Trignani M, Vinciguerra A, Augurio A, Di Tommaso M, Perrotti F, De Paoli A, Olmi P, Valentini V, Di Nicola M. Interobserver variability of clinical target volume delineation in soft-tissue sarcomas. *Cancer Radiother*. 2014;18:89–96.
14. Spoelstra FO, Senan S, Le Pechoux C, Ishikura S, Casas F, Ball D, Price A, De Ruysscher D, van Sornsen de Koste JR. Variations in target volume definition for postoperative radiotherapy in stage III non-small-cell lung cancer: analysis of an international contouring study. *Int J Radiat Oncol Biol Phys*. 2010;76:1106–13.

15. Grabarz D, Panzarella T, Bezjak A, McLean M, Elder C, Wong RK. Quantifying interobserver variation in target definition in palliative radiotherapy. *Int J Radiat Oncol Biol Phys*. 2011;80:1498–504.
16. Matuszak MM, Hadley SW, Feng M, Hayman JA, Brock KK, Burger P, Owen D, Suresh K, Schipper M, Lawrence TS, Moran JM. Enhancing safety and quality through preplanning peer review for patients undergoing stereotactic body radiation therapy. *Pract Radiat Oncol*. 2016;6:e39–46.
17. Hamilton SN, Hasan H, Parsons C, Tyldesley S, Howard AF, Bobinski MA, Goddard K. Canadian radiation oncologists' opinions regarding peer review: a national survey. *Pract Radiat Oncol*. 2015;5:120–6.
18. Cox BW, Kapur A, Sharma A, Lee L, Bloom B, Sharma R, Goode G, Potters L. Prospective contouring rounds: a novel, high-impact tool for optimizing quality assurance. *Pract Radiat Oncol*. 2015;5:e431–6.
19. Vogt WB, Town R, Williams CH. How has hospital consolidation affected the price and quality of hospital care? *Synth Proj Res Synth Rep.* 2006:15231.
20. Thaker NG, Sturdevant L, Jhingran A, Das P, Delclos ME, Gunn GB, McAleer MF, Tereffe W, Choi SL, Frank SJ, Simeone WJ Jr, Martinez W, Hahn SM, Famiglietti R, Kuban DA. Assessing the quality of a radiation oncology case-based, peer-review program in an integrated academic and community cancer center network. *J Oncol Pract*. 2016;12:e476–86.
21. Wilson RR. Radiological use of fast protons. *Radiology*. 1946;47:487–91.
22. Mishra MV, Aggarwal S, Bentzen SM, Knight N, Mehta MP, Regine WF. Establishing evidence-based indications for proton therapy: an overview of current clinical trials. *Int J Radiat Oncol Biol Phys*. 2017;97:228–35.