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Technical Report

Managing motion in conventionally fractionated lung cancer radiation therapy: Collaborative quality improvement from a statewide consortium of academic and community practices

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Introduction

The Michigan Radiation Oncology Quality Consortium (MROQC), funded by Blue Cross and Blue Shield of Michigan and Blue Care Network, was founded in 2011 as a collaborative effort between academic and community practice radiation oncology centers in the state of Michigan to assess the utilization of and need for advanced planning and delivery techniques in the treatment of breast and lung cancer patients. The consortium currently includes 22 active institutions. As part of the group's efforts, several quality improvement projects have been initiated, such as the promotion of accelerated whole breast fractionation in eligible patients.[1] In late 2014, a project was initiated to increase utilization of respiratory motion assessment for definitive, conventionally fractionated patients with lung cancer. Although national recommendations suggest motion assessment for patients in whom respiratory motion is expected to have a potential effect on treatment,[2,3] our data showed a consortium utilization rate of only 56%, with some institutions much lower than that. It can be difficult to predict which tumors may benefit from motion management techniques during treatment planning and/or delivery,[3-5] although the extent of motion, on average, is increased in nonattached and lower lobe tumors.

The lack of accurate motion assessment and management leads to incomplete understanding of the planned and delivered doses in patients with lung cancer and undermines our ability to characterize the relationship between dose and toxicity as well as dose and local control. Although guidelines for motion assessment exist, utilization of these guidelines outside of clinical trials is largely unknown. Given the high variability across institutions and the perceived underutilization of motion assessment in MROQC, a working group was formed to study the potential reasons for underutilization, identify barriers to efficient use, and develop and recommend "good practices" that could help institutions improve their utilization rates. Here we present the results of our quality improvement efforts regarding motion assessment utilization and provide, as a supplement to this article (Appendix E1; available as supplementary material online only at www.practicalradonc.org), the "good practice" guidelines report that was developed and adopted by the consortium.

Baseline data collection and analysis

The lung patient cohort collected as part of MROQC includes all patients receiving conventionally fractionated radiation therapy with definitive intent at each of the participating institutions. Patients receiving stereotactic body radiation therapy or having prior thoracic radiation or metastatic disease are not eligible. After radiation is completed, clinical and technical data are collected. On the technical side, a data abstractor from the treating institution, usually a dosimetrist, completes a patient-specific treatment survey regarding the simulation, contouring, and treatment planning.[6] Surveys include information regarding the use of and type of motion assessment (eg, 4-dimensional computed tomography [4DCT], fluoroscopy, up-front motion management) and any use of motion management techniques for simulation and/or treatment. At the onset of this project, of a total of 680 patients treated from 2011 through the third quarter of 2014, the rate of motion assessment was 56%, with highly variable between-institution rates ranging from ~10% to 100% (Fig 1).

All sites had motion assessment capabilities, with all but 1 institution having 4DCT capabilities. To appreciate the strategies used, Fig 2 shows the types of motion assessment performed, by institution, for all MROQC lung cancer patients treated before the third quarter of 2014. Here, we see that 4DCT is the predominant motion assessment strategy.

The gathered baseline data suggested that there could be barriers to successful motion assessment at many institutions. Based on discussions within the working group and at quarterly consortium meetings, barriers to routine motion assessment included a lack of (1) software and/or hardware resources, (2) knowledge of efficient implementation, and/or (3) belief that it was necessary and beneficial to perform motion assessment for conventionally fractionated lung patients; for example, slow 4DCT reconstruction hindered motion assessment at several centers.

Although we believed use of motion assessment had been well established in the literature, it was clear to the working group that education could play a large role in improving its adoption in clinical practice. In addition, the lack of knowledge and resources available to perform motion assessment safely, effectively, and efficiently was a concern that we sought to address through institutional site visits and subsequent publication of good practices relating to the utilization of motion assessment.

Good practices observations and suggestions report

Members of the motion assessment working group participated in 6 site visits to MROQC institutions that volunteered to open their departments to demonstrate their motion assessment and management strategies for lung cancer patients. Based on these visits and survey information, the working group drafted a good practices summary report that was adopted as an approved guideline of the consortium. This report is included in Appendix E2 of this article. The goal of the report is to aid institutions in improving the quality, safety, and efficiency of motion assessment practices in their departments. Because many high-quality practices are represented with a variety of different techniques and equipment, we purposely avoided

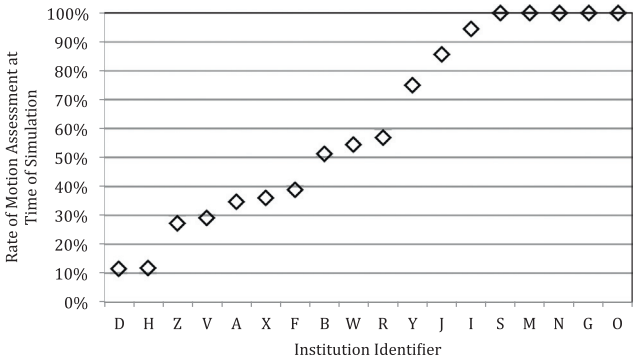

Figure 1 Rate of motion assessment at the time of simulation for lung patients treated at individual MROQC institutions from 2011 until the third quarter of 2014.

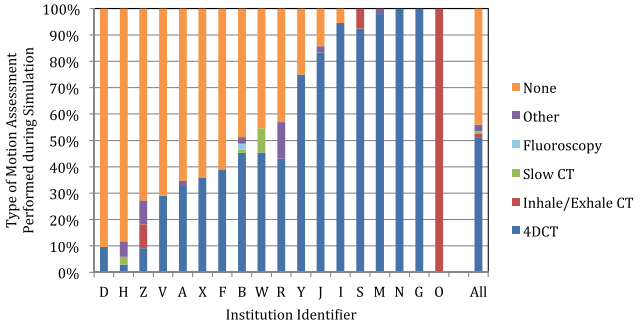

Figure 2 Motion assessment strategies used at the time of simulation for MROQC patients, by institution, from 2011 through the third quarter of 2014 (before initiation of the motion assessment quality improvement working group). CT, computed tomography; 4DCT, 4-dimensional computed tomography.

recommending "best practices" and instead tried to highlight practices that we deemed positive in light of safe, quality, and efficient motion assessment and management for lung cancer radiation therapy. The good practices are organized into 4 categories: general, simulation, contouring/image fusion, and image guidance.

Quality improvement results

Starting in the last quarter of 2014, the motion assessment working group began educating the consortium on the merits of motion assessment through a series of quarterly presentations. In addition, each institution was provided with quarterly practice reports along with the ability to self-generate reports as desired, summarizing their utilization of motion assessment relative to the entire consortium. Starting in 2015, annual motion assessment performance metrics were used as part of a pay-for-performance measure of the MROQC funding model through Blue Cross and Blue Shield of Michigan and Blue Care Network. Institutions with motion assessment rates $\geq$85% were given the maximum number of points, those at 50% to 84% received 80% of points, 25% to 49% rates received 40% of points, and <25% earned 0 points. The

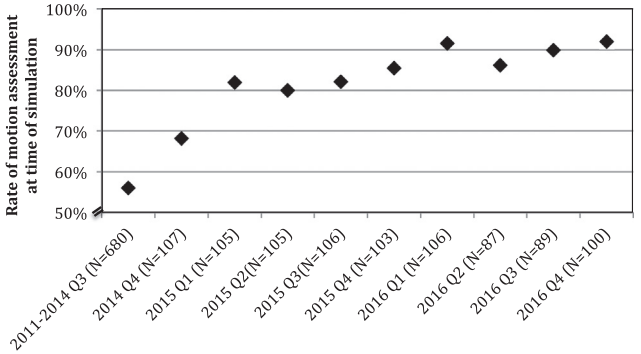

Figure 3 Rates of motion assessment before working group initiation and quarterly afterwards. Q, quarter.

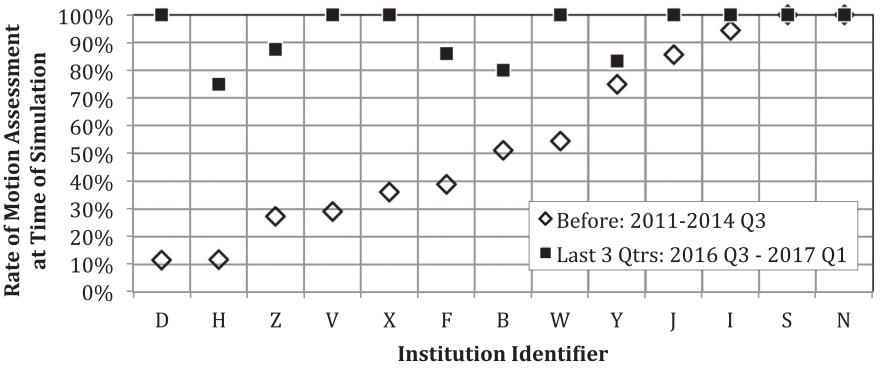

Figure 4 Improvement in motion assessment by institution from before working group initiation to the values for the last 3 quarters. Only institutions with at least 5 patients during each period are shown. Abbreviation as in Fig 3.

quarterly rates show a steady increase in the utilization of motion assessment, with the consortium average increasing from 56% to 92% (Fig 3).

Figure 4 shows an increase in the use of motion assessment per institution before the quality improvement project began compared with the last 3 quarters. Only institutions with at least 5 patients in both time periods are shown. Because some centers have low numbers of cases and quarterly tracking may be misleading, sites are provided data over the last 3 quarters for quality improvement tracking. Improvement is noted for each institution represented; several institutions had very marked improvements, improving from initial rates of motion assessment of 10% to 30% to >70%. As in the baseline data, 4DCT remains the most used mode of motion assessment, representing 92% of motion assessment procedures. Although each institution has a unique situation, increased awareness, standardization across providers, improved workflows, more efficient hardware/software, and points-based incentives are all believed to have contributed to the improved utilization of motion assessment.

Summary

Here, we have summarized the efforts of a statewide consortium in radiation oncology toward increasing the rates of motion assessment for conventionally fractionated definitive lung cancer patients from 56% to >90% over approximately 1 year through the use of educational presentations, utilization reports, and the sharing of good practices. A summary of the good practices observed throughout the consortium are provided as practical and feasible suggestions for institutions aiming to effectively and efficiently increase their utilization of motion assessment. This work provides an important assessment of how motion management may be used or not used outside of clinical trial settings. This work has been shown to lead to substantial improvements at the participating centers. We hope that our consortium experience and good practice guidelines may stimulate departments outside of our consortium to reevaluate and increase their use of motion assessment for all lung cancer patients receiving definitive radiation therapy.

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References

1. Jagsi R, Griffith KA, Heimburger D, Walker EM, Grills IS, Boike T, et al. Choosing wisely? Patterns and correlates of the use of hypofractionated whole-breast radiation therapy in the state of Michigan. *Int J Radiat Oncol Biol Phys.* 2014;90:1010-1016.
2. ASTRO A. ACR–ASTRO practice parameter for image-guided radiation therapy (IGRT). 2014. (revised).
3. Keall PJ, Mageras GS, Balter JM, et al. The management of respiratory motion in radiation oncology report of AAPM Task Group 76. *Med Phys.* 2006;33:3874-3900.
4. Liu HH, Balter P, Tutt T, et al. Assessing respiration-induced tumor motion and internal target volume using four-dimensional computed tomography for radiotherapy of lung cancer. *Int J Radiat Oncol Biol Phys.* 2007;68:531-540.
5. Seppenwoolde Y, Shirato H, Kitamura K, et al. Precise and real-time measurement of 3D tumor motion in lung due to breathing and heartbeat, measured during radiotherapy. *Int J Radiat Oncol Biol Phys.* 2002;53:822-834.
6. Moran JM, Feng M, Benedetti LA, Marsh R, Griffith KA, Matuszak MM, et al. Development of a model web-based system to support a statewide quality consortium in radiation oncology. *Pract Radiat Oncol.* 2017;7:e205-e213.