

QUALITY IMPROVEMENT

The Michigan Radiation Oncology Quality Consortium: A Novel Initiative to Improve the Quality of Radiation Oncology Care



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Purpose: Numerous quality measures have been proposed in radiation oncology, and initiatives to improve access to high-complexity care, quality, and equity are needed. We describe the design and evaluate effect of a voluntary statewide collaboration for quality improvement in radiation oncology initiated a decade ago.

Methods and Materials: We evaluate compliance before and since implementation of annual metrics for quality improvement, using an observational data set with information from more than 20,000 patients treated in the 28 participating radiation oncology practices. At thrice-yearly meetings, experts have spoken regarding trends within the field and inspired discussions regarding potential targets for quality improvement. Blinded data on practices at various sites have been provided. Following Standards for Quality Improvement Reporting Excellence guidelines, we describe the approach and measures the program has implemented. To evaluate effect, we compare compliance at baseline and now with active measures using mixed effects regression models with site-level random effects.

Results: Compliance has increased, including use of guideline-concordant hypofractionated radiation therapy, doses to targets or normal tissues, motion management, and consistency in delineating and naming contoured structures (a precondition for

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Data sharing statement: Data are owned by the local collaborating sites and therefore MROQC is not permitted to share the data used for this study.

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quality evaluation). For example, use of guideline-concordant hypofractionation for breast cancer increased from 47% to 97%, adherence to target coverage goals and heart dose limits for dose increased from 46% to 86%, motion assessment in patients with lung cancer increased from 52% to 94%, and use of standard nomenclature increased from 53% to 82% for lung patients and from 80% to 94% for breast patients (all $P < .001$).

Conclusions: Although observational analysis cannot fully exclude secular trends, contextual data revealing slow uptake of best practices elsewhere in the United States and qualitative feedback from participants suggests that this initiative has improved the consistency, efficiency, and quality of radiation oncology care in its member practices and may be a model for oncology quality improvement more generally. © 2022 Elsevier Inc. All rights reserved.

Introduction

Large-scale initiatives to promote equitable access to high-quality complex medical care could meaningfully improve the public health. Blue Cross Blue Shield of Michigan (BCBSM) has sponsored numerous statewide or regional collaborative quality initiatives (CQIs), using a model of payment for participation combined with streamlined reimbursement processes for high-performing sites to encourage quality improvement. Previous research has shown how even modest improvements in surgical complications could yield substantial savings to third-party payers supporting such efforts,¹ and numerous reports have detailed the effect of the specific surgical programs in outcomes ranging from reduction of venous thromboembolism to meaningful weight reduction after bariatric surgery.²⁻¹⁶ Although the initial collaborations involved surgical fields, the BCBSM Value Partnerships Program has ultimately grown to include initiatives in other disciplines, including radiation oncology.

Within radiation oncology care, quality involves the administration of treatment that yields tumor control while minimizing toxicity and burden for patients.^{17,18} Although numerous quality measures have been proposed, and research has identified a number of readily measurable surrogate endpoints such as dose to critical structures that predict for subsequent toxicity in patients,^{19,20} few collaborative interprofessional efforts designed to optimize the quality of radiation oncology care exist.

Sufficient experience has now accumulated to evaluate the effect of one such initiative, the Michigan Radiation Oncology Quality Consortium (MROQC), funded by BCBSM, which is an insurer/payer, on care delivery in participating practices. This article details the activities of the initiative as a whole and the first 3 site-specific working groups of MROQC, focused on breast cancer, lung cancer, and bone metastases. Specifically, it evaluates time trends in data collected to illuminate the effects thus far of this statewide initiative and inform similar efforts elsewhere.

Methods

Methods overview

To evaluate the effect of this comprehensive quality improvement initiative, following Standards for Quality

Improvement Reporting Excellence (SQUIRE) guidelines,²¹ we describe the overall structure and approach of the program. We detail the incentive structures that have been developed to encourage participation and quality.

Next, we detail the history of specific measures that the program has developed and implemented. We describe baseline (in the year before initiation of a measure) and current rates of compliance with measures among participating practices. We also provide more detailed information regarding compliance over time with select consensus standards and trends over time in each of 3 areas that have been the focus of major efforts within the consortium: motion management, hypofractionation, and consistent use of recommended nomenclature.

Finally, we provide complementary evidence from the qualitative analysis of an open-ended item included in a survey of consortium clinical champions and site administrators, asking participants to reflect on the effect of the initiative. These responses were thematically coded²² and are summarized based on content, with illustrative quotations.

Statistical methods

Patient level outcomes were largely binary measures and were summarized as binomial proportions with 95% Wilson score confidence intervals (CIs) for eligible patients. Mixed effect logistic regression models were used to test the hypotheses that the proportion of patients meeting a particular measure changed from the year before initiation to the most recent complete year (2020), which is the period that is described as “now” or “current” in the results. Site level random effects were included to account for expected correlation within site and some changing of participating sites over time. In all cases, performance was calculated over a standardized period (January 1 to September 30 for each calendar year) to mirror current practice for reporting to BCBSM used to determine sites' reimbursement as detailed further in the description of the program that follows in the results section. We note that this was not always the case, and for this reason and due to the live nature of the MROQC database, some measures may not exactly match prior publications. SAS version 9.4 was used for all statistical analysis and a 2-sided.05 significance level was used. Because these efforts were primarily intended for quality

improvement rather than designed to develop or contribute to generalizable knowledge, the University of Michigan Institutional Review Board determined that it was a nonregulated quality improvement activity.

Results

Overall structure and approach

Planning for MROQC began in 2010 at the University of Michigan, which was designated by BCBSM as the coordinating center of a collaborative quality initiative for radiation oncology. Experts in radiation oncology, medical physics, dosimetry, patient-reported outcomes evaluation, biostatistics, information technology, and quality improvement convened to determine what modifications of the existing model that had been implemented primarily in surgical disciplines were needed to accommodate the context of radiation oncology quality improvement. It was soon apparent that a labor-intensive but necessary precondition of a collaborative quality initiative specific to radiation oncology was the development of a customized and universally accessible infrastructure that could gather the complex imaging and dosimetric data from various radiation treatment planning systems that must be analyzed to optimize care in this particular field, as described in detail elsewhere.²³

The remainder of the program design was heavily influenced by the experience in the existing surgical quality initiatives supported by BCBSM, with a plan to support the participation of diverse practices across the state through a combination of direct payments for staff and infrastructure (based on number of patient cases) and incentives that reward demonstrated excellence in quality. Unlike some collaborative quality initiatives in which participation is required, practices interested in participating in MROQC join voluntarily by contacting the coordinating center. A pay for performance approach evaluates practices based on submission of data and compliance with a number of process and outcomes measures that are proposed by the cancer-site specific working groups each year and discussed, revised, and ultimately endorsed by consensus at a consortium meeting. Appendix EA details the scoring system used for the current year of the initiative.

As an additional incentive for high quality care, a “gold card” system eliminates time-consuming prior authorization requirements to streamline reimbursement for high-performing practices; this is true for all cases covered by BCBSM, not only those with diseases currently being evaluated in the consortium, with the exception of cases involving use of proton therapy. Since 2017, those practices who meet specific criteria set by the consortium and BCBSM have been granted “gold card” status. In the first year that gold carding was offered 43% of practices qualified; for 2021, all 27 practices qualified for gold card status. Table EA details

the current “gold card” criteria. Table EB shows the number and percent of practices qualifying for gold card status since the initiation of this incentive.

A third incentive for high-quality care involves value-based reimbursement, which provides up to a 5% increase in provider fee-for-service payments for those meeting specified measures. The value-based reimbursement system is described in further detail in Appendix EB.

Development of and compliance with measures

MROQC began data collection in 2012, including patient-level data collected from providers and patients themselves, detailed treatment planning information, and administrative practice-level data; these data are audited regularly to ensure their quality. Since the initiation of the consortium, radiation oncologists, medical physicists, dosimetrists, data abstractors, statisticians, and practice administrators from sites across the state of Michigan have convened thrice yearly in person (and virtually in 2020 and 2021). Meeting attendance has been high, with more than 90% of sites sending at least a physician clinical champion and most also sending a medical physicist or dosimetrist, data abstractor, and administrative lead. At these meetings, expert speakers have spoken regarding trends within the field and inspired discussions regarding potential targets for quality improvement within the consortium. Blinded data on practices at various sites have also been regularly presented, and the group has iteratively developed new initiatives and consensus-based benchmarks intended to improve radiation oncology care delivery and patient experiences and outcomes of care, with regular meetings of site-specific working groups focused on breast cancer, lung cancer, and bone metastases; recently, a prostate cancer working group has been added and interventions will soon include patients with prostate cancer as well. Of the 27 sites currently participating, 5 are academic sites and the remaining 22 sites are community practices. Practice volume varies from low to very high. When assessed by grouping based on total nonspecial megavoltage radiation therapy visits as reported for state certificate of need purposes in 2018, 3 sites had low volume of cases (0-5000), 4 had moderate volume (5001-10,000), 13 had high volume (10,000-15,000), and 7 had extremely high volume (>15,000).

Table 1 provides an overview of the primary form of intervention in the consortium, which involves the identification of targets for quality improvement, with specific measures and setting of targets. As detailed in the table, increased proportions of patients in the consortium met prespecified thresholds for compliance after each measure was specified. For example, use of guideline-concordant hypofractionation for breast cancer increased from 47% (95% CI, 40%-53%) in 2014 to 97% (95% CI, 96%-98%) now, adherence to target coverage goals and heart dose limits for dose increased from 46% (95% CI, 30%-64%) in 2019

Table 1 Implementation of quality improvement measures

Measure*	Year initiated	Baseline rate: year before initiation of measure (95% CI)	Current target rate	Current rate (95% CI)	P value†
Use hypofractionation in guideline-concordant breast patients	2014	47% (40,53)	≥90%	97% (96,98)	<.001
Motion assessment in lung patients	2014	52% (45,59)	≥90%	94% (91,96)	<.001
Limit mean heart dose in patients with breast cancer to specified maxima‡	2015	62%‡ (59,65)	≥85%‡	97%‡ (95,98)	<.001
PTV expansion drawn around lumpectomy cavity for breast patients	2017	41% (39,44)	≥80%	98% (97,98)	<.001
Lung GTV defined per consortium guidelines	2017	76% (71,81)	≥90%	97% (94,98)	<.001
Lung PTV defined per consortium guidelines	2017	81% (75,85)	≥90%	88% (83,91)	.005
Avoid >10 fractions for bone metastases§	2019	97% (95,98)	≥80%	98% (97,99)	.723
≥95% of PTV receives ≥100% of prescription dose AND mean heart dose ≤20 Gy for lung patients	2019	46% (30,64)	≥65%	86% (82,89)	<.001
Use TG-263 standards for heart, PTV, esophagus, spinal cord or canal, and normal lung for lung cancer patients	2020	53% (48,59)	≥50%	82% (77,86)	<.001
Use TG-263 standards for heart, breast PTV, lumpectomy cavity PTV, and ipsilateral lung for breast cancer patients	2020	80% (78,82)	≥80%	94% (93,96)	<.001
Use single fraction for uncomplicated bone metastases	2020	15% (10,22)	≥20%	28% (22,37)	.018
Breast boost omission in low-risk patients	2020	55% (36,54)	>70%	64% (55,72)	.224

CI = confidence interval; GTV = gross tumor volume; PTV = planning target volume; TG-263 = American Association of Physicists in Medicine's Task Group 263.

* Measures in bold remain active; measures not bolded are in maintenance (no longer tied to pay for performance scoring).

† P values correspond to test of null hypothesis of equal rates in a mixed-effects logistic regression model with time (baseline vs current) and random site level intercept to account for correlated observations within site.

‡ Mean heart dose limits were changed over time. The baseline rate in 2015 reflects the initial goal, which was <2 Gy mean heart dose regardless of fractionation or laterality. In 2019, the goals were changed as follows. For patients receiving conventional fractionation, the goals are ≤1.7 Gy (left-sided) or ≤1 Gy (right-sided). For patients receiving hypofractionation, the goals are ≤1.2 Gy (left-sided) or ≤0.7 Gy (right-sided). The current rate reflects the percentage meeting this new (stricter) definition.

§ Initial measure for bone metastasis management was determined based on a 2018 survey of sites that suggested that use of extended (>10 fraction) regimens remained common practice. Because compliance was so high both before and after measure implementation, this measure was rapidly retired and replaced with the measurement of use of single fraction radiation for uncomplicated bone metastases.

to 86% (95% CI, 82%-89%) now, motion assessment in patients with lung cancer increased from 52% (95% CI, 45%-59%) in 2014 to 94% (95% CI, 91%-96%) now, and use of standard nomenclature increased from 53% (95% CI, 48%-59%) to 82% (95% CI, 77%-86%) for lung patients and from 80% (95% CI, 78%-82%) to 94% (95% CI, 93%-96%) for breast patients.

Of note, thresholds and goals for compliance are deliberately not set to 100%, to account for individual patient heterogeneity that may make compliance with a particular practice inappropriate. Initial targets are set close to historical levels and then iteratively increased before a consistent and sufficient level of compliance is achieved, at which point the measure is put into maintenance and no

longer included in the system of allocating points for the pay-for-performance aspect of the program. Nevertheless, as seen in the table, high rates of compliance continue to be observed even for measures in maintenance. In some instances, a prior measure is combined with a new measure to confirm that the prior gains are retained and to build further on that success. This is especially helpful when considering tradeoffs between dosimetric coverage of targets and tradeoffs for doses to organs-at-risk, as exemplified by the current measure that includes requirements for both planning target volume (PTV) coverage and limits on mean heart dose for patients with lung cancer, building on a prior measure that had focused on PTV coverage alone.

Figure 1 shows how data on compliance with each measure is presented to individual sites, to guide their quality improvement efforts and allow them to benchmark against their peers. Sites not only receive data on their overall performance but also the performance of individual physicians within the practice.

A more detailed depiction of compliance with a single measure, motion management in the treatment of lung cancer, is presented over time in Figure 2. As shown, over time, the target rate was adjusted to encourage increasing levels of compliance, and compliance increased over time, both at the per-site level (number of sites where a prespecified percent of patients at that site meet expectations) and at the per-patient level in the consortium overall.

Increasing utilization of hypofractionation in the treatment of breast cancer and bone metastases is depicted in Figure 3. Of note, given new consensus guidelines published in 2018 for whole breast irradiation,²⁴ the definition of “eligible patients” was changed to become more inclusive, and there was a transient dip in performance at that time, followed by a continued trajectory of increase.

Figure 4 shows increasing compliance within the consortium with the use of standards articulated by the American Association of Physicists in Medicine’s Task Group 263 (TG-263) for nomenclature for specific contoured structures in patients with breast and lung cancer in the consortium since the year of publication of that report.²⁵

Participants’ perspectives

Results of an open-ended item included in a survey of attendees at the February 2021 consortium meeting

provided vivid descriptions of consortium participants’ perceptions of the effect of the initiative, almost entirely positive (of 31 comments provided in total, only 4 included negative or critical content). Some comments reflected on the effect of sharing of best practices, learning from one another, and developing a culture of quality improvement. As one participant noted: “Our focus on sharing best practices, as defined in peer reviewed, published trials, has helped us to improve the quality and efficiency of radiation therapy.” Another remarked, “MROQC has helped to foster a real culture of quality improvement in our practice. By spending time with peers and seeing benchmarking data, we are inspired to do better and learn how we can. I learn something at every meeting.”

Others commented on the importance of accountability. As one respondent noted, “MROQC has markedly changed our clinical practice. The performance measures have provided a level of accountability that we were lacking. It is very important for us to see how we compare to our peers.” Another stated, “The reports are helpful for taking feedback to our practice on areas of successful improvement and areas where we still need work.”

Some reflected on how the collection of patient-reported outcomes in the consortium empowered patients in ways that also elevated quality. As one respondent described, “My perception of the MROQC project is that it gives patients the opportunity to be more involved in their care and also allows them to feel heard, both extremely important elements when referencing quality of care.” Another noted, “I feel that the patients benefit from their communication with MROQC as it gives them a unique opportunity to share

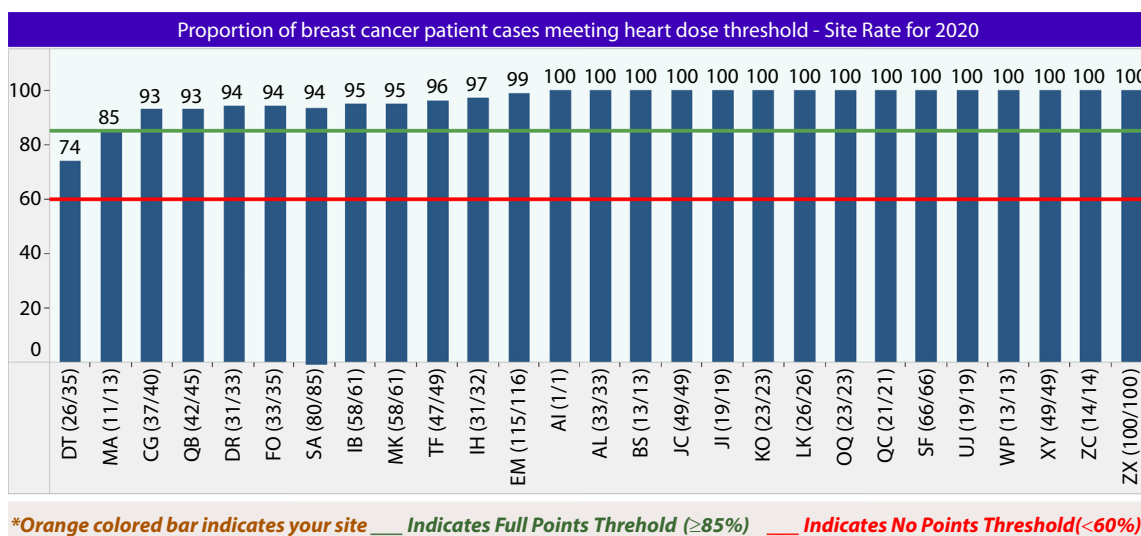


Fig. 1. Report provided to sites to evaluate compliance with measures. (A) Single-site data in the context of peers for a single measure (mean heart dose in 2020). (B) Data for specific individual physicians, whose names and number of eligible cases are also shown in the report provided to the site by MROQC (exhibit deliberately truncated inferiorly for purposes of publication).

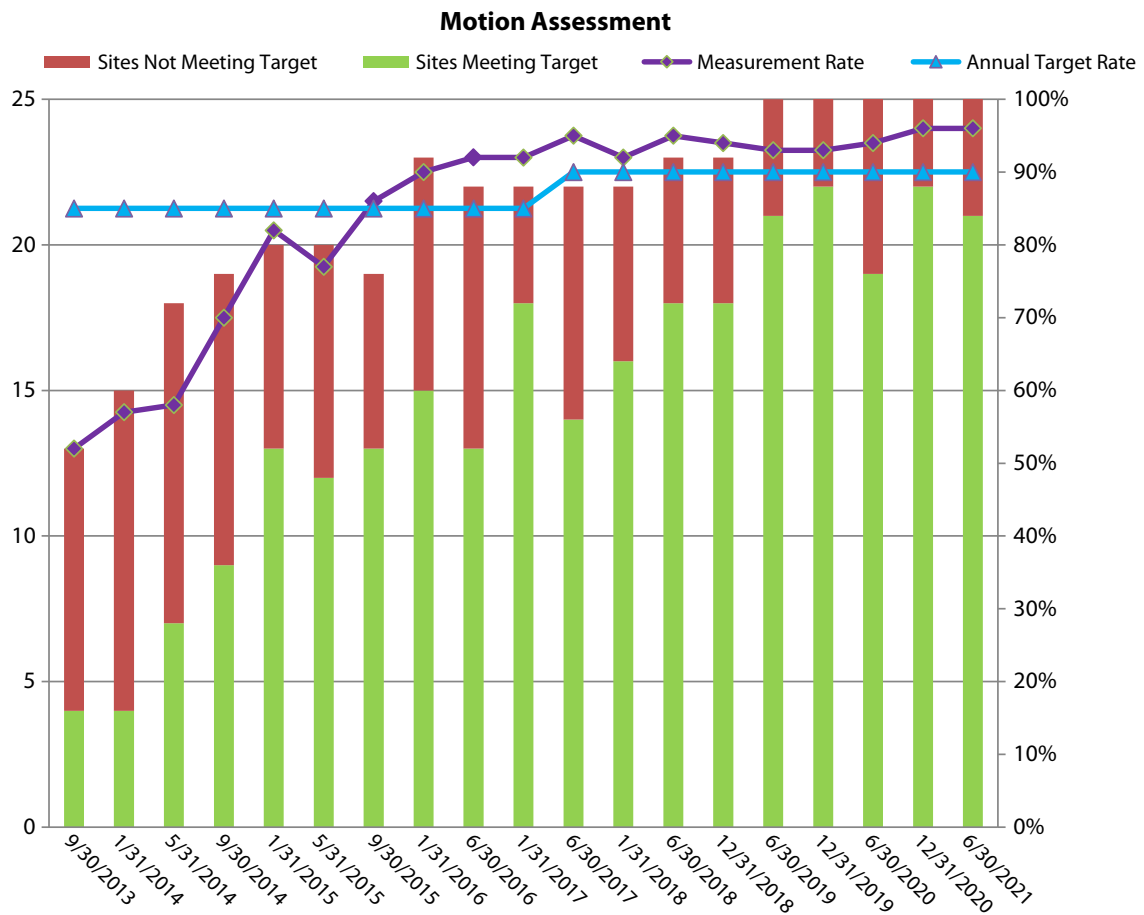


Fig. 2. Target rates and compliance with motion assessment in patients with lung cancer over time. Measurement rate is the percentage of patients in the consortium who had motion assessment as part of their treatment planning. The annual target rate is the percentage of a single site’s patients who must have had motion assessment in order for the site to receive full points in the pay-for-performance evaluation (and be counted as a “site meeting target” in the figure).

their personal experience and receive feedback regarding treatment and care.”

The few negative comments focused on how certain efforts might seem more academic in nature and strain

the resources of community centers: “Some of the things being done are more research based than quality. . . . [A]s a community based hospital it is more than we are staffed for.”

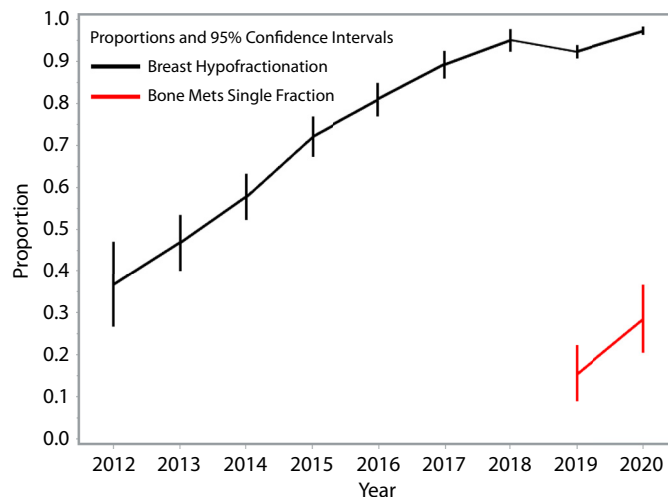


Fig. 3. Hypofractionation use in eligible patients over time. The use of hypofractionation among patients with breast cancer and bone metastases is defined as eligible per the criteria in the footnotes.

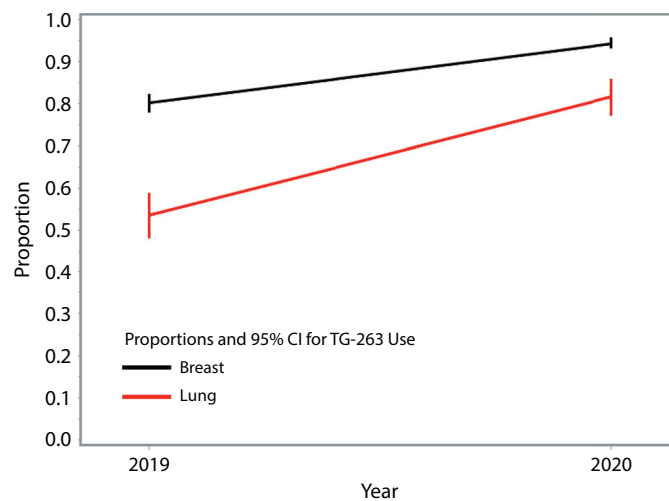


Fig. 4. The percentage of patients in whom there has been use of the American Association of Physicists in Medicine’s Task Group 263 (TG-263) standards. The measure initiated in 2020 was disease site–specific and required use of the TG-263 standards for heart, planning target volume (PTV), esophagus, spinal cord or canal, and normal lung for lung cancer patients, and use of the TG-263 standards for heart, breast PTV, lumpectomy cavity PTV, and ipsilateral lung for patients with breast cancer.

Discussion

MROQC has now collected detailed observational data from more than 20,000 patients treated with radiation therapy and specified a number of measurable targets for quality improvement. Comparisons of rates of compliance with quality measures before their specification and now, along with qualitative perceptions of participants, suggest meaningful transformation in both processes and outcomes of care in this setting. Specifically, care transformation appears to have resulted from the unique intervention that involves a consensus-based approach to defining targets for quality improvement and the collection and regular presentation of site-specific data.

These findings are consistent with those reported from quality initiatives in other fields within the BCBSM collaborative framework. As Sheetz and Engelsbe have described, the state of Michigan is home to 25 active CQIs that engage the medical community in setting a quality improvement agenda to inform value-based reimbursement and pay-for-performance programs.²⁶ MROQC adheres to the same basic principles as its peer CQIs in other specialties, using incentive programs that are nonpunitive and build on the quality improvement agenda defined by the medical community. Legitimacy of the endeavor is buttressed by support for the collection of patient-reported outcomes and data that are accurate, timely, and relevant. The engagement of the provider community as well as patients in the initiative have been remarkable, as evidenced by attendance at meetings and working groups as well as submission of provider-reported and patient-reported data.

Changes observed in the context of this CQI are clinically meaningful. For example, improvement in the efficiency of care delivery through increased use of hypofractionation in

appropriate patients has clear benefits. The increased use in this setting is remarkable because uptake of hypofractionation has been slow in other settings,²⁷⁻²⁹ although examples of other quality improvement interventions^{30,31} and payer incentives³² have suggested the ability to encourage use, just as in this endeavor.

Similarly, reductions in doses to critical normal structures, particularly the heart, are essential to reduce treatment-related morbidity and mortality.¹⁹ Nevertheless, mean heart doses reported in the literature have remained high at other centers,³³ whereas they have fallen within this particular consortium for patients treated for breast cancer,³⁴ and current efforts focus on addressing heart dose in the management of patients with lung cancer.³⁵

In addition to outcomes measures like fractionation use and doses to normal tissues (a surrogate known to predict toxicity), the findings reported in this manuscript suggest improvement in process measures of great importance. The increasing rate of compliance with standardized nomenclature is particularly noteworthy because adherence to such standards constitutes a precondition for consistent interinstitutional quality evaluation.²⁵ Future research should strive to assess effect of such initiatives and improvements in process measures on patient outcomes directly.

Although this endeavor appears to have had numerous positive aspects, it is not without costs. Although BCBSM provides financial support, our qualitative findings suggest that certain aspects of the program may strain staffing, particularly for community sites. Burden on participating sites can be an important unintended consequence of quality improvement initiatives that those seeking to build on this model must keep in mind. Detailed economic analyses have not been conducted and would be a worthy subject for future research. A simple internal analysis that compared

bone metastasis fractionation schedules within the consortium and nationally suggested that between 2018 and 2020, practices in MROQC saved their payers (including but not limited to the sponsor of the consortium) over \$4.5M in this one area alone, suggesting that models like this do have the potential to generate substantial cost savings.

One key limitation of this work is that observational analysis cannot fully exclude secular trends. Given the lack of national registries in the United States with detailed radiation therapy treatment information, comparison to contemporaneous practice elsewhere is challenging. Nevertheless, contextual data revealing slow uptake of best practices elsewhere in the United States suggests that MROQC has improved the consistency, efficiency, and quality of radiation oncology care in its member practices. For example, Parikh et al³² have reported from a data set of administrative claims data that in 2018, 82% of patients eligible for hypofractionated breast radiation therapy received it among fully insured patients whose plans included a utilization management policy that did not reimburse for extended courses (as did 80% of self-insured patients who were not subject to the utilization management policy); the rate within this consortium as shown in Figure 3 in 2018 was 95% (95% CI, 93%-98%). Qualitative data suggest that the improvements observed relate to the ways that the consortium promotes the sharing of best practices and to the culture of the quality-minded participants in the collaborative.

A second important limitation relates to generalizability. Participation in this consortium is voluntary, and the results may not apply if extrapolated beyond practices sufficiently committed to quality improvement to voluntarily engage in such efforts. That said, as in CQIs implemented in other areas of practice like surgery, the provision of financial support for staff effort involved in participation, together with incentives provided by BCBSM through payments for participation, value-based reimbursement, and streamlining of reimbursement for sites that demonstrate excellence, have facilitated widespread participation in the state. Indeed, the current consortium represents 40% of radiation oncology practices and treats 60% of all patients treated with radiation therapy in the state of Michigan.

Conclusions

In summary, MROQC is a model of an ambitious prospective professionally driven quality improvement effort across a large state. Such initiatives have great promise to increase access to appropriate high-complexity care and improved health equity in radiation oncology, which are high priorities for promoting the public's health. Of note, the metrics identified by MROQC may be more appropriate targets for national efforts to improve quality of radiation oncology care and more intuitively appealing to practicing radiation oncologists than measures currently use in, for example, the Centers for Medicare and Medicaid Services Merit-based

Incentive Program. Nevertheless, efforts to extend this work to the national level require caution because part of the success of MROQC appears to derive from the interactions of consortium members with one another. Development of other regional initiatives modeled on MROQC might lead to greater heterogeneity in targets for improvement but with greater participant buy-in necessary for success. Ongoing evaluation of the sort presented in the current manuscript will be necessary to assess various approaches to scaling up quality improvement efforts in radiation oncology beyond the level of a single state.

In conclusion, the evidence collected to date in this large-scale quality improvement initiative initiated over a decade ago suggests that this effort has improved the consistency, efficiency, and quality of radiation oncology care in its member practices. MROQC may therefore represent a model for quality improvement of radiation oncology care more generally, allowing the field to optimize the benefit delivered to patients while minimizing toxic effects, burden, and expense.

References

- Englesbe MJ, Dimick JB, Sonnenday CJ, Share DA, Campbell Jr. DA. The Michigan surgical quality collaborative: Will a statewide quality improvement initiative pay for itself? *Ann Surg* 2007;246:1100-1103.
- Moscucci M, Share D, Kline-Rogers E, et al. The Blue Cross Blue Shield of Michigan Cardiovascular Consortium (BMC2) collaborative quality improvement initiative in percutaneous coronary interventions. *J Interv Cardiol* 2002;15:381-386.
- Chang V, Schwab JM, Nerenz DR, et al. The Michigan Spine Surgery Improvement Collaborative: A statewide Collaborative Quality Initiative. *Neurosurg Focus* 2015;39:E7.
- Chinnaiyan KM, Depetris AM, Al-Mallah M, et al. Rationale, design, and goals of the Advanced Cardiovascular Imaging Consortium (ACIC): A Blue Cross Blue Shield of Michigan collaborative quality improvement project. *Am Heart J* 2012;163:346-353.
- Barnes GD, Birkmeyer N, Flanders SA, et al. Venous thromboembolism: A collaborative quality improvement model for practitioners, hospitals, and insurers. *J Thromb Thrombolysis* 2012;33:274-279.
- Hood BR, Cowen ME, Zheng HT, Hughes RE, Singal B, Hallstrom BR. Association of aspirin with prevention of venous thromboembolism in patients after total knee arthroplasty compared with other anticoagulants: A noninferiority analysis. *JAMA Surg* 2019;154:65-72.
- Zarling BJ, Sikora-Klak J, Bergum C, Markel DC. How do preoperative medications influence outcomes after total joint arthroplasty? *J Arthroplasty* 2017;32:S259-S262.
- Milojevic M, Bond C, Theurer PF, et al. The role of regional collaboratives in quality improvement: Time to organize, and how? *Semin Thorac Cardiovasc Surg* 2020;32:8-13.
- Sukul D, Seth M, Dupree JM, et al. Drivers of variation in 90-day episode payments after percutaneous coronary intervention. *Circ Cardiovasc Interv* 2019;12:e006928.
- Machado-Aranda DA, Jakubus JL, Wahl WL, et al. Reduction in venous thromboembolism events: Trauma performance improvement and loop closure through participation in a state-wide quality collaborative. *J Am Coll Surg* 2015;221:661-668.
- Varban OA, Cassidy RB, Bonham A, Carlin AM, Ghaferi A, Finks JF. Factors associated with achieving a body mass index of less than 30 after bariatric surgery. Michigan Bariatric Surgery Collaborative. *JAMA Surg* 2017;152:1058-1064.

12. Hughes RE, Batra A, Hallstrom BR. Arthroplasty registries around the world: Valuable sources of hip implant revision risk data. *Curr Rev Musculoskelet Med* 2017;10:240–252.
13. Zakaria HM, Bazydlo M, Schultz L, et al. Adverse events and their risk factors 90 days after cervical spine surgery: Analysis from the Michigan Spine Surgery Improvement Collaborative. *J Neurosurg Spine* 2019;1–13.
14. Ghaferi AA, Wells EE. Improving postoperative rescue through a multifaceted approach. *Surg Clin North Am* 2021;101:71–80.
15. Foster C, Posada C, Pack B, Hallstrom BR, Hughes RE. Summary of knee implant one, three, five, and 10-year revision risk reported by national and regional arthroplasty registries: A valuable source of evidence for clinical decision-making. *EFORT Open Rev* 2020;5:268–272.
16. Tignanelli CJ, Hemmila MR, Rogers MAM, Raghavendran K. Nationwide cohort study of independent risk factors for acute respiratory distress syndrome after trauma. *Trauma Surg Acute Care Open* 2019;4:e000249.
17. American Society for Radiation Oncology. Safety is no accident: A framework for quality radiation oncology care. Available at: <https://www.astro.org/Patient-Care-and-Research/Patient-Safety/Safety-is-no-Accident>. Accessed March 31, 2019.
18. Bentzen SM, Constine LS, Deasy JO, et al. Quantitative analyses of normal tissue effects in the clinic (QUANTEC): An introduction to the scientific issues. *Int J Radiat Oncol Biol Phys* 2010;76:S3–S9.
19. Darby SC, Ewertz M, McGale P, et al. Risk of ischemic heart disease in women after radiotherapy for breast cancer. *N Engl J Med* 2013;368:987–998.
20. Atkins KM, Chaunzwa TL, Lamba N, et al. Association of left anterior descending coronary artery radiation dose with major adverse cardiac events and mortality in patients with non-small cell lung cancer. *JAMA Oncol* 2021;7:206–219.
21. Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D. SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): Revised publication guidelines from a detailed consensus process. *BMJ Qual Saf* 2016;25:986–992.
22. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;3:77–101.
23. Moran JM, Feng M, Benedetti LA, 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. <https://doi.org/10.1016/j.prro.2016.10.002>.
24. Smith BD, Bellon JR, Blitzblau R, et al. Radiation therapy for the whole breast: Executive summary of an American Society for Radiation Oncology (ASTRO) evidence-based guideline. *Pract Radiat Oncol* 2018;8:145–152.
25. American Association of Physicists in Medicine. Standardizing Nomenclatures in Radiation Oncology (2018) Nomenclatures in Radiation Oncology. 2018 January; Report No. 263.
26. Sheetz KH, Englesbe MJ. Expanding the quality collaborative model as a blueprint for higher-value care. *JAMA Health Forum* 2020;1:e200413.
27. Jagsi R, Falchook AD, Hendrix LH, Curry H, Chen RC. Adoption of hypofractionated radiation therapy for breast cancer after publication of randomized trials. *Int J Radiat Oncol Biol Phys* 2014; 90:1001–1009.
28. Bekelman JE, Sylwestrzak G, Barron J, et al. Uptake and costs of hypofractionated vs conventional whole breast irradiation after breast conserving surgery in the United States, 2008–2013. *JAMA* 2014;312:2542–2550.
29. Bekelman JE, Epstein AJ, Emanuel EJ. Single- vs multiple-fraction radiotherapy for bone metastases from prostate cancer. *JAMA* 2013;310:1501–1502.
30. Powell AC, Ceylan M, Long JW, Deshmukh UU, Loy B, Mirhadi AJ. Rate of whole-breast hypofractionated radiation therapy before versus after virtual tumor board implementation. *JCO Oncol Pract* 2021;17:e809–e816.
31. Chen KS, Glaser SM, Garda AE, et al. Utilizing clinical pathways and web-based conferences to improve quality of care in a large integrated network using breast cancer radiation therapy as the model. *Radiat Oncol* 2018;13:44.
32. Parikh RB, Fishman E, Chi W, et al. Association of utilization management policy with uptake of hypofractionated radiotherapy among patients with early-stage breast cancer. *JAMA Oncol* 2020;6: 839–846.
33. Taylor CW, Wang Z, Macaulay E, Jagsi R, Duane F, Darby SC. Exposure of the heart in breast cancer radiation therapy: A systematic review of heart doses published during 2003 to 2013. *Int J Radiat Oncol Biol Phys* 2015;93:845–853.
34. Pierce LJ, Feng M, Griffith KA, et al. Recent Time Trends and Predictors of Heart Dose from Breast Radiation Therapy in a Large Quality Consortium of Radiation Oncology Practices. *Int J Radiat Oncol Biol Phys* 2017;99:1154–1161.
35. Dess RT, Sun Y, Muenz DG, et al. Cardiac Dose in Locally Advanced Lung Cancer: Results from a Statewide Consortium. *Pract Rad Oncol* 2020;10:e27–e36. <https://doi.org/10.1016/j.prro.2019.07.013>.