International Journal of Radiation Oncology biology • physics

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Quality Assurance

VA-Radiation Oncology Quality Surveillance Program

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Received Jun 28, 2019. Accepted for publication Aug 21, 2019.

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The funding for this project was provided by the Veterans Health Administration of the U.S. government.

Disclosures: R.K. is a VCU employee providing full time contracted services at VA. J.M. received a stipend from ASTRO for this project. H.S. received a stipend from ASTRO for this project; personal fees from Astra Zeneca, Novocure, IBA, and Janssen; and other from Radiogel, outside the submitted work. B.M. received a stipend from ASTRO for this project and other from ASTRO, during the conduct of the study; grants from Varian, Inc and Philips, Inc; and personal fees from View Ray Inc, outside the submitted work. I.C. received grants from Varian Medical Systems (Palo Alto, CA) and Philips HealthCare (Best, Netherlands), outside the submitted work. R.R. received personal fees from Astra Zeneca, Novocure, and IBA, outside the submitted work. C.R. received grants and personal fees from Varian, grants from Elekta, and other from Radialogica, outside the submitted work. A.R. received a stipend from ASRO for this project; institutional support from NIH/NCI Cancer Center Support Grant P30 CA008748; grants from Varian Medical Systems, Boehringer Ingelheim, and Pfizer; grants and personal fees from AstraZeneca and Merck; personal fees from Research to Practice, Cybrexa, and MoreHealth; and nonfinancial support from Philips/Elekta. D.H. received personal fees from ASTRO, during the conduct of the study; grants and personal fees from Augmenix; and personal fees from Boston Scientific, outside the submitted work. S.M.: received a stipend from ASTRO for this project; grants from the Veterans Health Administration; grants and other from Varian Medical Systems, Radialogica, and TreatSafely, during the conduct of the study; and grants and other from Varian Medical Systems outside the submitted work. W.B. received grants from the US Veterans Health Administration, during the conduct of the study, and other from American Association of Physicists in Medicine, outside the submitted work. D.C. received a stipend from ASTRO for this project. D.C. reports grants from the Veterans Health Administration, during the conduct of the study. R.B. reports being an employee of Radialogica, LLC, and receiving grants from the Veterans Health Administration, during the conduct of the study. J.R.P. reports being a VCU employee providing 0.7FTE contracted services at the VA. J.N. receives personal fees from Veteran Affairs Administration, during the conduct of the study. W.S. receives personal fees from Veteran Affairs Administration, during the conduct of the study.

Supplementary material for this article can be found at https://doi.org/10.1016/j.ijrobp.2019.08.064.

Acknowledgments—The authors thank the members of ASTRO staff led by Ms. Emily Wilson and Ksenija Kujundzic.

Int J Radiation Oncol Biol Phys, Vol. 106, No. 3, pp. 639–647, 2020
0360-3016/$ - see front matter
https://doi.org/10.1016/j.ijrobp.2019.08.064

Summary

Veterans Health Administration has partnered with Washington University and the American Society for Radiation Oncology to create a Radiation Oncology Practice Assessment (ROPA) program. Establishing comprehensive quality metrics for radiation oncology care management and treatment delivery for cancers of the lung or prostate. ROPA examined 1576 veterans treated in the 40 Veterans Health Administration radiation therapy practices. The overall pass rate for all quality metrics was 82.4% and 88% for dose-volume measures. While practices performed well overall, ROPA revealed high-performing practices and areas for improvement in each practice. ROPA has set the stage for continuous, electronic peer reviews based upon national standards.

Purpose: We sought to develop a quality surveillance program for approximately 15,000 US veterans treated at the 40 radiation oncology facilities at the Veterans Affairs (VA) hospitals each year.

Methods and Materials: State-of-the-art technologies were used with the goal to improve clinical outcomes while providing the best possible care to veterans. To measure quality of care and service rendered to veterans, the Veterans Health Administration established the VA Radiation Oncology Quality Surveillance program. The program carries forward the American College of Radiology Quality Research in Radiation Oncology project methodology of assessing the wide variation in practice pattern and quality of care in radiation therapy by developing clinical quality measures (QM) used as quality indices. These QM data provide feedback to physicians by identifying areas for improvement in the process of care and identifying the adoption of evidence-based recommendations for radiation therapy.

Results: Disease-site expert panels organized by the American Society for Radiation Oncology (ASTRO) defined quality measures and established scoring criteria for prostate cancer (intermediate and high risk), non-small cell lung cancer (IIIA/B stage), and small cell lung cancer (limited stage) case presentations. Data elements for 1567 patients from the 40 VA radiation oncology practices were abstracted from the electronic medical records and treatment management and planning systems. Overall, the 1567 assessed cases passed 82.4% of all QM. Pass rates for QM for the 773 lung and 794 prostate cases were 78.0% and 87.2%, respectively. Marked variations, however, were noted in the pass rates for QM when tumor site, clinical pathway, or performing centers were separately examined.

Conclusions: The peer-review protected VA-Radiation Oncology Surveillance program based on clinical quality measures allows providers to compare their clinical practice to peers and to make meaningful adjustments in their personal patterns of care unobtrusively.

Introduction

Advancing technologies in health care each year bring a sharper focus on clinical outcome assessment and the assessment of health care quality. Improved precision and accuracy in therapeutic and diagnostic use of artificial intelligence and the availability of big data offer new tools for better health care delivery. With these more impactful new tools recognized as "disruptive technologies," the assessment of health care quality must keep stride.

For 50 years, the radiation oncology community has examined its practices through the Patterns of Care (POC) studies of the American College of Radiology (ACR).[1,2] In the early 2000s, the POC studies matured into a series of reports detailing the penetration of findings from clinical trials into clinical practice in academic centers and the larger community.[3,4] As a natural follow-on, these POC observations led to the development of clinical performance measures, identified by leaders in each of their respective areas and through which radiation oncology practices could generally be assessed.[4-6] The ACR Quality Research in Radiation Oncology (QRRO) project[7,8] clearly demonstrated that adherence to these quality measures affected outcomes important to patients and providers and provide a measure of the quality of care. In a related effort, academic centers have shared their prospective peer reviews with wider regional audiences.[9-11] ACR has long supported prospective peer reviews as the most helpful form of peer assessments in radiation therapy. By extending prospective reviews to regional practices, groups have identified significantly improved treatment in a substantial percentage of cases planned by the local partner.[9,12] Combining the notion of evidence-based clinical performance measures with electronic, prospective peer reviews, the Veterans Affairs (VA) Radiation Oncology Quality Surveillance (VA-ROQS) program introduces quality metrics (QM) developed by panels of experts into a peer review setting designed to operate in the background during daily practice. This resource allows radiation oncologists to view detailed, comprehensive quality assessments of each case scored against national standards.

Implementing VA-ROQS infrastructure for cancers of the prostate or lung, the pilot program described here established expert panels and developed relevant QM and a

web-based, secure QM scoring system. The QM, their derivations, and scores for each of the VA's radiation oncology practices are detailed in this report.

Methods and Materials

Building on an original ACR proposal for practice assessments of the VA radiation oncology practices, the VA National Radiation Oncology Program (NROP) partnered with Washington University at St. Louis (WUSTL) and the American Society for Radiation Oncology (ASTRO) to pilot the VA-ROQS program. The pilot effort addressed intermediate-risk and high-risk prostate cancers (CaP), stage IIIA/B non-small cell lung cancers (NSCLC), and limited stage small cell lung cancers (SCLC). These 3 disease site presentations were selected for the VA-ROQS pilot because radiation therapy is pivotal in the treatment of these cancers, which together represent more than 60% of patients receiving radiation therapy in the VA.

ASTRO identified tumor site panels composed of nationally recognized experts who were asked to identify QM for each phase of management by the radiation oncologist and dose metrics. Panels defined QM in 3 categories: currently expected performance metrics, those anticipated for the near future (aspirational QM), and QM for surveillance only. QM descriptions, detailed in Appendix EA (available online at https://doi.org/10.1016/j.ijrobp.2019.08.064), included original definitions, appropriate inclusions and exclusions, scoring methods, and target scores.

The team from WUSTL partnered with NROP to develop methods for manual data abstraction, analytical methods for digital imaging and communications in medicine (DICOM) data, data curation, and the data scoring system. The WUSTL team also developed web tools to report patient scores to the VA radiation oncologists and aggregate data to VA quality managers. From 2016 to 2018, the VA-ROQS pilot project examined 1567 cases from the 40 VA radiation oncology practices. Cases were serially selected from each practice to include 20 CaP, 20 NSCLC, and 10 SCLC. Data collected included diagnosis, staging, imaging, performance status, simulation and dose-volume histogram (DVH)-based objectives, use of androgen depletion therapy (long vs short term), complete DICOM data set, toxicity information, survivorship care plan and follow-up assessments.

These data, collected from the electronic medical records (EMR), treatment management system (TMS), and treatment planning system, were curated to score 19 QM for lung tumors and 26 QM for prostate cancers. Panels selected 34 additional measures based on dose-volume (DV) criteria extracted from the DICOM plan data, The evaluation of each QM required extensive decision-tree logic to construct a "pass" or a "fail" score. The clinical and dosimetry data elements that were manually abstracted from the EMR, TMS, and treatment planning system were plugged into flowchart-based decision trees. The decision trees were constructed based on the underlying quality measure focus, expected outcomes, target population, and exclusion criteria, if any. Pass/fail and not applicable scores were derived from these decision trees for each QM and for each evaluated patient. Patient scores, aggregate scoring, and scores relative to other centers were delivered to Veterans Health Administration providers via a secure, web-based dashboard portal.

Results

Overall, the 1567 assessed cases passed 82.4% of all QM. Excluding aspirational and surveillance metrics, the overall pass rate was 86.4% for the currently expected performance metrics. Pass rates for QM for the 773 lung and 794 prostate cases were 80.0% and 87.2%, respectively. Marked variations, however, were noted in the pass rates for QM when tumor site, clinical pathway, or performing centers were separately examined.

Pass rates for each QM developed for intermediate-risk or high-risk prostate cancers are shown in Figure 1. Although pass rates were above 80% for the majority of QM and similar among the 40 centers studied, the pass rates for documentation of treatment options for intermediate-risk patients (GU QM 4) and frequency of follow-up (GU QM 18) varied widely. The 4 aspirational QMs, quality-of-life assessment at consult (GU QM 5), survivorship care plan (GU QM 16), quality-of-life assessment at follow-up (GU QM19), and baseline bone health assessment (GU QM24) were deficient or nearly so in 12, 40, 17, and 30 centers, respectively. Likewise, the surveillance metrics, enrollment in clinical trial (GU QM 6), androgen depletion therapy for intermediate-risk patients (GU QM 10), and comprehensive treatment for high-risk patients (GU QM12) scored very low pass rates from 39, 26, and 21 centers, respectively.

Tumor site committees recommended 34 quality measures based on DV data. The combined pass rate for both lung and prostate DV measures was 88%. Sixteen quality measures evaluated DV data for the prostate cases by examining coverage of the planning target volume and doses to bowel, femurs, bladder, and rectum. Of the 6 separately recommended DV limits listed in Appendix EA (available online at https://doi.org/10.1016/j.ijrobp.2019.08.064) for the rectum, 5 were scored. The mean pass rates for all centers exceeded the 90% threshold for 10 of 16 limits, including both planning target volume measures. Mean pass rates for 3 rectal measures, V75Gy $<$10%, V70Gy $<$25%, and V40Gy $<$45%, fell below the 90% target at 76%, 78%, and 84% of cases, respectively. Dmax constraints for small and large bowel doses and 1 of the 2 bladder measures for the postprostatectomy setting also scored close to but below the 90% target at 88%, 84%, and 86% of cases, respectively. A summary of data on the performance of DVH-based QMs derived from the treatment plan is shown in Table 1.

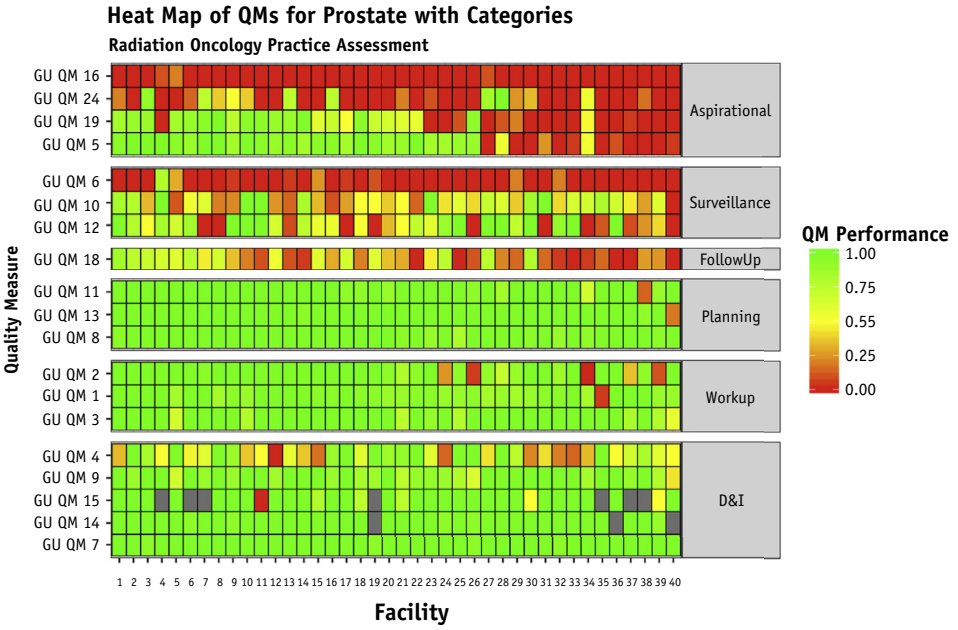

Fig. 1. Heat map of the quality measures (QM) for 794 patients with intermediate-risk or high-risk prostate cancer treated at 40 Veterans Affairs facilities. The QM were grouped in 6 broad categories: Aspirational, Surveillance, Follow-up, Treatment Planning, Initial Workup, and Diagnosis/Imaging. The overall pass rate for all QM was 87.2%.

Figure 2 shows, in a similar fashion, QM data developed for stage IIIA/B NSCLC and limited-stage SCLC. The majority of the 19 currently expected performance QMs (ie, not aspirational or for surveillance only) show equivalent pass rates. However, QMs related to smoking cessation (LU QM 8B), implanted cardiac devices (LU QM 10), motion management (LU QM 14), prophylactic cranial irradiation (LU QM 21A), and frequency of follow-up (LU QM 24) showed widely varying pass rates, with high numbers of failures at many centers. Aspirational metrics related to documentation

Table 1 Performance of dose-volume histogram–based quality measures for 794 patients with intermediate-risk or high-risk prostate cancer treated at 40 Veterans Affairs facilities

Dose-volume histogram quality measures	No. of centers exceeding ASTRO-defined expected performance	Mean passing (%)	No. of centers $1\sigma <$ mean
PTV_D2%	40	99	1
PTV_V100% Rx1	28	91	5
LargeBowel_D0.035cc	18	84	5
SmallBowel_D0.035cc	23	88	5
SmallBowel_V45Gy	37	98	3
Femur_R_V50Gy	40	100	0
Femur_L_V50Gy	40	100	0
Bladder - Bladder_Subtraction_ Structure_V40Gy	26	86	6
Bladder - Bladder_Subtraction_ Structure_V65Gy	36	97	4
Bladder_V65Gy	40	100	1
Bladder_V70Gy	40	99	4
Rectum_V40Gy	24	84	6
Rectum_V65Gy	30	94	7
Rectum_V50Gy	33	95	6
Rectum_V75Gy	14	76	6
Rectum_V70Gy	16	79	5

Abbreviation: ASTRO = American Society for Radiation Oncology.

The table shows the mean passing percentage for 794 patients from 40 Veterans Affairs facilities. Additional columns show the number of centers that exceeded the ASTRO-defined expected performance per quality measure and the number of centers below 1 standard deviation away from the mean passing rate.

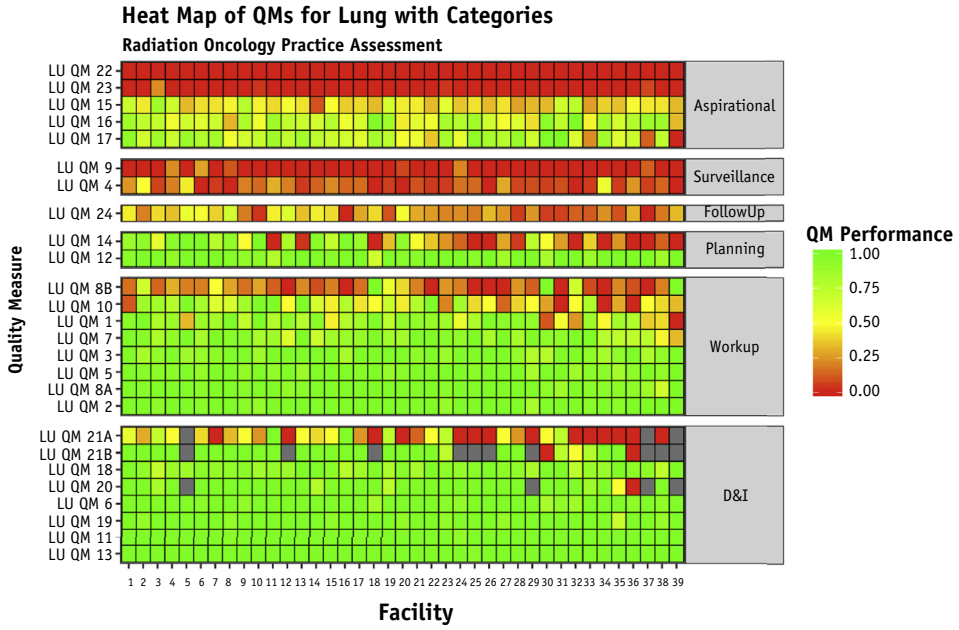

Fig. 2. Heat map of the quality measures (QM) for 773 patients with stage IIIA/B non-small cell lung cancer and limited-stage small cell lung cancer treated at 40 Veterans Affairs facilities. The QM were grouped in 6 broad categories: Aspirational, Surveillance, Follow-up, Treatment Planning, Initial Workup, and Diagnosis/Imaging. The overall pass rate for all QM was over 80%.

of an assessment for quality of life (LU QM 22) and the presence of a survivorship care plan (LU QM 23) were nearly uniformly missing from all centers, whilst aspirational measures related to treatment timeliness (LU QM 15-17) met established thresholds for more than 50% of cases in 12, 34, and 33 centers, respectively. Surveillance measures, collection of molecular data (LU QM 4), and participation in clinical trials (LU QM 9) were largely lacking.

Overall, centers scored modestly lower for the lung DV measures, with an average pass rate of 81.0% of all DV measures examined. The curation process noted data abstraction for 6 DV measures for the ipsilateral or contralateral single lung had failed to consider pneumonectomy, preventing the scoring of these measures. For the 11 scorable measures, however, the data in Table 2 show 8 scored above 80%, whereas for 3 mean pass rates exceeded 90% of cases. The mean score for the brachial plexus QM and 1 of the esophagus constraints scored low at 53% and 69% of cases, respectively. Although the majority of centers did well with total lung constraints, the V5Gy measure scored low at 58% of cases examined. For each DV measure, however, there were centers achieving a greater than 90% pass rate. For 5 of the 11 measures a majority of centers pass at the 90% level.

Figures 3 and 4 illustrate the performance of the entire VA enterprise for each quality measure assessed for patients with prostate and lung cancer. The green dots represent the top-performing VA facilities that have passing percentages above the ASTRO/NROP-defined expected performance rate. The red and orange dots represent the performance rates in the first and second quartiles for each quality measure. These figures provide visual estimates of potential gaps in quality care. Both figures illustrate opportunities for improvement in those QMs expert panels identified as aspirational and surveillance. The large variations in pass rates described identify those quality domains where some practices are challenged more than others. For prostate cancer cases, Figure 3 shows that mean values for aspirational QM varied from 57% to 88%, with mean passing rates for quality-of-life assessment at the original consult (QM 5) and presence of a survivorship care plan (QM 16) each scoring above their targeted pass rates. Two QM for performance (nonaspirational QM), however, scored low overall. Mean scores for QM 4 (discussion at consult of all potential therapies for intermediate risk CaP) and QM 18 (follow-up frequency) each scored low at 65% and 50%, respectively. Other QM mean scores showed good overall compliance while identifying several practices with apparent room for improvement. QM 2 (original consult includes stage, risk grouping, Gleason sum, and PSA) scored 88% overall, but with 4 practices below 50%. Likewise, QM related to low-dose-rate brachytherapy scored 88%, but 3 practices had low scores.

Practice variations were also identified for the QM for lung cancer. Although the mean pass rates for 10 QM for all practices were above their targeted values, as shown in Figure 4, 6 performance QMs for lung cancer scored mean pass rates below 70%. Use of prophylactic cranial irradiation for SCLC (QM21A/B), motion management (QM14), screening for implanted cardiac devices (QM10), and follow-up interval each identified room for improvement. However, centers performed better than expected for

Table 2 Performance of dose-volume histogram–based quality measures for 773 patients with stage IIIA/B non-small cell lung cancer and limited-stage small cell lung cancer treated at 39 Veterans Affairs facilities

Dose-volume histogram quality measures	No. of centers exceeding ASTRO-defined expected performance	Mean passing (%)	No. of centers $1\sigma <$ mean
Spinal Cord—Dmax (50 Gy) (Constraint)	39	99	6
Brachial Plexus—Dmax (66 Gy) (Constraint)	16	53	16
Lung (Total)—V20 Gy (37%) (Constraint)	29	88	3
Lung (Total)—V5 Gy (60%)	5	58	4
Lung (Total)—Dmean (20 Gy) (Constraint)	25	84	5
Ipsi-Lung (Single)—V20 Gy (7%) (Constraint)	0	1	0
Contra-Lung (Single)—V20 Gy (7%) (Constraint)	3	62	8
Ipsi-Lung (Single)—V5 Gy (60%)	0	29	5
Contra-Lung (Single)—V5 Gy (60%)	12	80	6
Ipsi Lung—Dmean (8.5 Gy) (Constraint)	0	3	0
Contra Lung—Dmean (8.5 Gy) (Constraint)	4	73	6
Esophagus—V60 Gy (17%)	8	69	4
Esophagus—Dmean (34 Gy)	18	82	4
Esophagus—Dmax (74 Gy)	35	94	2
Heart—V45 Gy (35%)	35	97	4
PTV—D95% (100% Rx) (Constraint)	19	86	4
PTV—Dmin (85% Rx)	14	81	6

Abbreviation: ASTRO = American Society for Radiation Oncology.

The table shows the mean passing percentage for 773 patients from 39 Veterans Affairs facilities. Additional columns show the number of centers that exceeded the ASTRO-defined expected performance per quality measure and the number of centers below 1 standard deviation away from the mean passing rate.

timeliness QMs deemed aspirational by the panel. Specifically, mean pass rates were 69% for timeliness of treatment delivery from consult (QM16) or from simulation (QM17), and mean timeliness scored from diagnosis (QM15) passed in 50% of cases.

Discussion

For more than 50 years, radiation oncologists have examined new treatment techniques, schedules, and modalities through clinical trials focused on discrete tumor presentations. Radiation oncology care standards developed by clinical trialists improve outcomes,[12,13] reduce toxicity,[14] maintain currency of the broader community of providers,[13,15] and vet new modalities,[16-20] all while setting the stage for each new wave of improvements.

Noting these advances, quality managers from ACR's QRRO program observed that care standards derived from trial results[4,6,21] were reflected in the practice patterns of a large group of radiation oncology practices.[21,22] Distilled from these efforts, clinical performance measures were advanced by QRRO investigators as a basis for practice evaluation.[20,21] QRRO teams showed these QM could be quantitated and measured against national averages to provide robust evaluations of practice quality of care.[21,22]

The demonstration that national experts, such as the various QRRO teams, could distill QM from current sources of high-level data provided the basis for using national standards for peer reviews. The VA quality surveillance program, VA-ROQS, combines these methods with the demonstration that data necessary for such a surveillance program could be reliably derived across a national practice base. The pilot study reported here used manually abstracted data to identify the electronic source in each of the VA's 40 practices. This work provides the basis for remote electronic data abstraction, which will allow VA-ROQS to operate continuously and passively provide QM scores to radiation oncologists through private web accounts. As forecasted by the QRRO researchers,[4,20] providers can see their QM scored against national averages and recommended targets from the ASTRO site panels.

Simultaneously, the de-identified aggregate data for each VA practice provides quality managers insight for assessing medical center performance not only against national standards, but also with respect to the performance of all centers within the health care system. Cancer-related outcomes, uniformity of prescriptions, timeliness of radiation delivery, and coordination of multidisciplinary care are important issues that can be selected for the center's dashboard to be monitored on a continuous basis.

The use of evidence-based QM identified by expert panels is important for both the radiation oncologist and the quality manager. Performance guidelines are useful only when the supporting data are clear. For example, for some VA centers, follow-up care is delivered in a multidisciplinary clinic or with another clinical service. As a result, scoring follow-up

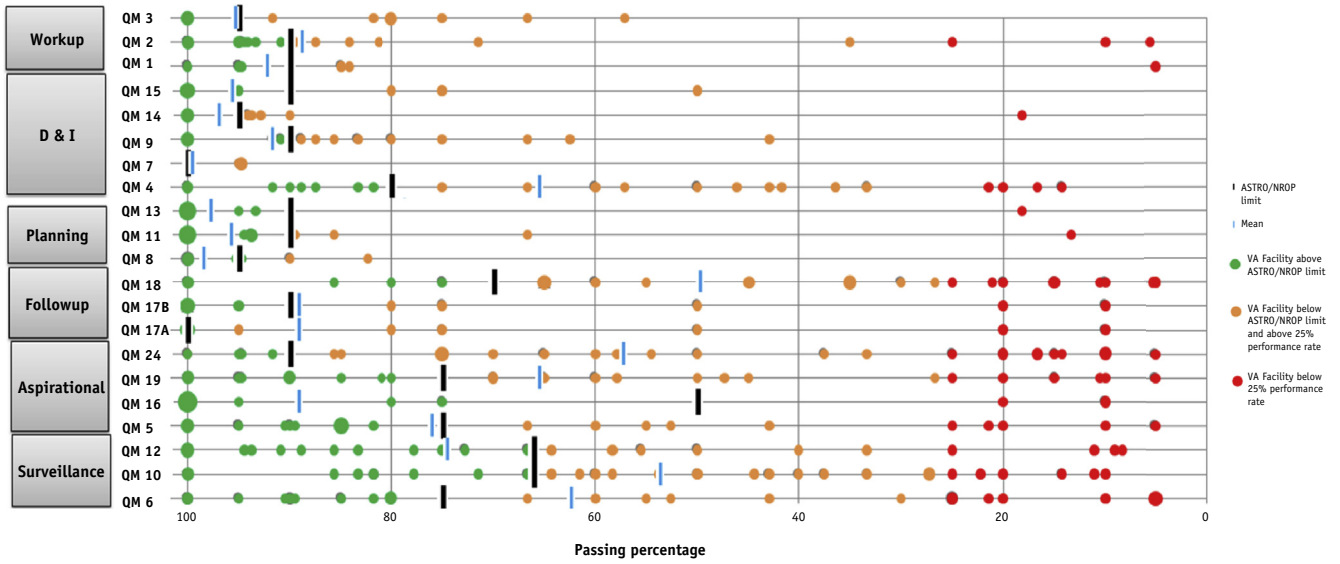

Fig. 3. Visual plot summarizing the performance for clinical quality measures (QM) for 794 patients with intermediate-risk or high-risk prostate cancer treated at 40 Veterans Affairs (VA) facilities (represented as dots). Each VA facility's passing percentage (x-axis) for every QM (y-axis) is displayed. Facilities with equal passing percentages overlap and are represented with larger dots. For every QM, green dots represent the top-performing VA facilities with passing percentages above the American Society for Radiation Oncology (ASTRO)/National Radiation Oncology Program (NROP)-defined expected performance rate. Orange dots represent median-performing VA facilities, and red dots represent VA facilities in the bottom quartile for performance rate. (A color version of this figure is available at https://doi.org/10.1016/j.ijrobp.2019.08.064).

within only the radiation oncology practice underreported the actual performance. Furthermore, for the pilot, DVH criteria for the untreated contralateral lung were used as an initial assessment of the ipsilateral lung as well. Thus, before implementing VA-ROQS and annually thereafter, QM are to be reviewed by the site panels. VA providers are encouraged to question the use of each QM with the aim to improve the utility of VA-ROQS.

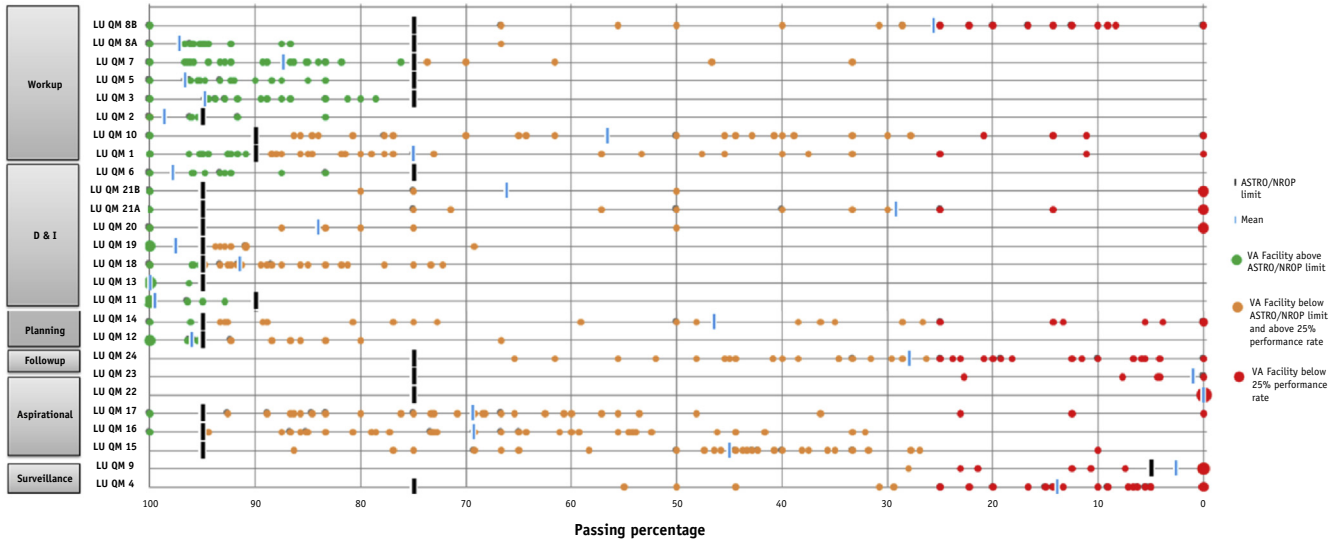

Fig. 4. Visual plot summarizing the performance for clinical quality measures (QM) for 773 patients with stage IIIA/B non-small cell lung cancer and limited-stage small cell lung cancer treated at 40 Veterans Affairs (VA) facilities (represented as dots). Each VA facility's passing percentage (x-axis) for every QM (y-axis) is displayed. Facilities with equal passing percentages overlap and are represented with larger dots. For every QM, green dots represent the top-performing VA facilities with passing percentages above the American Society for Radiation Oncology (ASTRO)/National Radiation Oncology Program (NROP)-defined expected performance rate. Orange dots represent median-performing VA facilities, and red dots represent VA facilities in the bottom quartile for performance rate. (A color version of this figure is available at https://doi.org/10.1016/j.ijrobp.2019.08.064).

QM defined and applied as described in the VA-ROQS pilot identified substantial similarity of the VA radiation oncology practices, a likely product of their repeated ACR accreditations.[23] Notwithstanding this congruence, the identification of aspirational QM by the panels of experts points toward novel efforts and important targets for improvement that can be approached systematically to benefit patients and the health care system generally. More importantly, case-by-case scoring offers individual providers continuous reviews of their patient evaluation and planning processes as well as treatment delivery and outcomes, all collected in a peer-review protected format.

VA-ROQS development continues now with the refinement of current QM, expansion to additional tumor sites, and integration of structured templates into the EMR. Data abstraction for the pilot has identified the need to gather data from other VA programs, such as the VA's well-developed smoking cessation program, which was not linked in this effort, and the VA-National Health Physics Program, which monitors each center's low-dose-rate brachytherapy program. As mentioned earlier, variations in clinical practices were incompletely considered. For example, some VA centers conduct radiation oncology follow-up within a multidisciplinary follow-up clinic, which must be linked to the abstraction process.

Examining multiple centers requires that QMs reflect variations in dose, fractionation, and structure segmentation. Though each of these considerations introduces complexity, methods exist to improve QM relevancy. Adjusting dose constraints, benchmarking to biologically equivalent dosing, and electronic recognition of contouring outliers are each under consideration for future efforts.

With much of the infrastructure now in place, VA-ROQS is positioned to become a key resource for the radiation oncologist. These measures and pass rates may not only support quality improvement for the VA system but also motivate community practices to surpass these new benchmarks. Ultimately, the success of this effort to improve quality lies in a belief that well-designed feedback to each provider will create a roadmap for improved patient care. Furthermore, continuous feedback will allow providers to monitor their progress and the progress of their patients.

Conclusions

Driven by a unique partnership between clinicians and physicists, radiation oncology is a highly technical specialty enjoying a long history of quality assurance. As advanced high-fluence-rate treatment platforms, more precise treatment delivery, and multiple methods for intratherapy beam modulation are developed, quality assurance tools able to confirm the accuracy of radiation delivery with millimeter precision are keeping pace. Simple "Record and Verify" software developed decades ago has matured into sophisticated TMSs monitoring patient care and radiation delivery. Each year, these TMS include new quality domains. Uniform use of EMR and TMS has created a quality infrastructure that, when directed by appropriate QM, can passively assess treatment planning, treatment delivery, and the quality of provider performance. By operating quality surveillance in a peer-review protected environment, providers can make meaningful adjustments in their personal patterns of care, and quality managers can view aggregate practice performance against national benchmarks.

Finally, recent concerns about the national quality of cancer care prompted the Institute of Medicine to convene a committee of experts to formulate recommendations for the improvement of cancer care delivery. *Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis*[24] presents the committee's findings and recommendations. One of the key recommendations was to develop a national quality program based on evidence-based standardized measures for cancer care as part of a learning health care system. These measures would then be used for self-assessment or external review of the quality of care. Recently, the Centers for Medicare and Medicaid Services released a Radiation Oncology Model[25] that aligns payments to quality and value, rather than volume. It is likely that the Centers for Medicare and Medicaid Services Radiation Oncology Model will tie payments to quality measure performance and third-party payors will follow suit as they seek data to ensure their beneficiaries are receiving high-quality care. Given the current environment of quality-driven health care, the VA-ROQS program is well poised to become a de facto model for quality care in radiation oncology.

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