BNs to improve situation awareness of pART before and during radiotherapy. Area under the free-response receiver operating characteristics (AU-FROC) was used with cross-validation (CV) to evaluate simultaneous prediction performance of LC/RP2 in a joint BN modeling framework.
Results: BNs were successfully formed for prediction of LC and/or RP2 before and during radiotherapy from three machine learning scenarios. Hierarchical relationships among those data types can be appreciated in the resulting BN graphs. The prediction performance of HITL outperformed those of EK or machine only approaches resulting in tighter confidence intervals (CIs) (Table 1).
Conclusion: Our subjective BNs based HITL DSS improves radiation outcome prediction compared to current EK and machine only, and has the potential to be an important component of pART DSS. However, it may need further external independent validation via multi-institutional collaborations.
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An Image-Based Framework for Individualizing Radiotherapy Dose

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Purpose/Objective(s): Radiotherapy continues to be delivered uniformly without taking into account individual tumor characteristics. We queried the lung computed tomography (CT)-derived feature space to identify radiation sensitivity parameters that can predict treatment failure and hence guide the individualization of radiotherapy dose.
Materials/Methods: We used a cohort-based registry of 849 patients with cancer in the lung treated with high-dose radiotherapy. We input pre-therapy lung CT images into a deep neural network, Deep Profiler, to generate an image fingerprint that primarily predicts treatment outcomes and secondarily approximates classical radiomic features. Deep Profiler was combined with electronic health records (EHR) data to derive an individualized radiation dose, *i*Gray, a patient-specific dose that reduces treatment failure probability to $<5\%$.
Results: Patients with high Deep Profiler scores fail radiation at a significantly higher rate than in those with low scores. The 3-year cumulative incidences of local failure were 20.3% (95% CI: 16.0-24.9) and 5.7% (95% CI: 3.5-8.8), respectively. Deep Profiler independently predicted local failure (hazard ratio 1.65, 95% 1.02-2.66, $p=.042$). Models that included Deep Profiler and EHR predicted treatment failures with a concordance index of 0.721, a significant improvement compared to classical radiomics or clinical variables alone ($p=4.64\times10^{-14}$ and 4.57×10^{-22}, respectively). *i*Gray had a wide dose range (21.1-277 Gy, BED), suggested dose reduction in 23.3% of patients and can be safely delivered in the majority of cases. Voxel saliency maps indicate that 37.4% of the voxels that are most deterministic for treatment failure localize outside of the physician-contoured tumor volume.
Conclusion: Our image-based deep learning framework is the first opportunity to use medical images to individualize radiation dose delivery.
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Association between Adverse Events and Quality of Life in Patients Treated with Radiotherapy for Locally Advanced Non-Small Cell Lung Cancer

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Purpose/Objective(s): Clinician-reported adverse events (AEs) and declines in patient-reported quality of life (QOL) are common during and after definitive radiotherapy (RT) for locally advanced non-small cell lung cancer (LA-NSCLC), but associations between these two outcomes are not well known. The purpose of this study was to assess associations between AEs and patient reported outcomes (PROs) including QOL at different time points during and after definitive radiotherapy for LA-NSCLC in a state-wide consortium.
Materials/Methods: Eligible patients included those treated with definitive RT for LA-NSCLC at 24 institutions within the Michigan Radiation Oncology Quality Consortium (MROQC) between 2012-2018 (n=1367). The Functional Assessment of Cancer Therapy Trial Outcome Index (FACT-TOI) was collected at baseline, end of treatment, and at 1, 3 and 6 months post-RT. The FACT-TOI includes 3 QOL components: Physical Well Being (PWB), Functional Well Being (FWB), and Lung Cancer Subscale (LCS). Clinicians graded AEs using CTCAE weekly during RT and at the same follow-up visits. An AE score was calculated as the sum of AE grades for pneumonitis, pleuritic pain, cough, dyspnea, esophagitis and esophageal pain at each time point. Spearman correlation coefficients were calculated for AEs and similar PROs, and between AEs and change in each QOL component from baseline. Changes in QOL were compared at different time points for patients with grade ≥ 2 esophagitis (versus grade ≤ 1) and grade ≥ 2 pneumonitis (versus grade ≤ 1) using Student's t-tests.
Results: All QOL domains declined from baseline to the end of RT then recovered at different rates up to 6 months after RT. Mean AE scores at end of RT and 1, 3, and 6 months post-RT were 3.3, 2.3, 2.2, and 2.3, respectively. Correlation coefficients ranged from 0.36 to 0.66 for AEs and similar PROs. Among AEs, esophagitis had the strongest correlation with change in PWB (r=-0.32), while dyspnea had the strongest correlation with change in FWB (r=-0.21) and LCS (r=-0.31). Correlations for AE score were slightly greater, with r=-0.39 for PWB, r=-0.25 for FWB, and r=-0.36 for LCS. The difference in average change in QOL from baseline between the two esophagitis groups was clinically meaningful and statistically significant during the last week of RT for PWB, and at 1 month post-RT for PWB and FWB but not for LCS (statistically significant only). Differences between the pneumonitis groups were clinically meaningful at 6 months post-RT for PWB and LCS, but they were not statistically significant.
Conclusion: Patients with higher quantity and severity of clinician-reported AEs have greater average declines in self-reported QOL during and after RT for LA-NSCLC. The associations between AEs and QOL were modest, however, suggesting that treatment-related AEs account for only a portion of QOL changes that patients experience, and reinforce the complementary nature of PROs and AEs.
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Quality of Life Based Total Cost Function (TCF) to Guide Treatment Plan Optimization for Head and Neck Cancer

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Purpose/Objective(s): A comprehensive range of NTCP-models for common toxicities has recently been developed and validated for definitive radiotherapy for head and neck cancer (HNC). However, it is currently unclear which toxicities are most relevant to patients and thus should get highest priority during treatment plan optimization. Therefore, the aim of this study was to develop a quality of life (QoL)-based Total Cost Function (TCF) that can be used to guide treatment optimization and to select the best treatment plan from a patient's perspective.

Materials/Methods: This prospective cohort study included 750 HNC patients treated with definitive radiotherapy with or without chemotherapy. Baseline patient- and treatment characteristics, as well as physician-rated CTCAEv4 and patient-rated outcome measures (i.e. EORTC QLQ-C30 and EORTC QLQ-HN35) were prospectively scored. QoL was defined as the average score of global health status and 5 functional scales of EORTC QLQ-C30 (scale 0-100) measured at 6, 12, 18 and 24 months. Eleven toxicities were measured at the same time points (Table 1). The impact of each toxicity on QoL was obtained by means of a two-step approach: 1) a principal component analysis (PCA), yielding components explaining most variance among the toxicities; 2) a linear regression analysis incorporating the PCA results and baseline factors to obtain the impact per toxicity and time point on QoL.

Results: The impact on QoL differed per toxicity. E.g., dysphagia grade 2-4 at 6 months reduced QoL with 2.0 points on a 100 points scale, while moderate to severe xerostomia reduced QoL with 0.8 point. The impact of dysphagia grade 2-4 increased over time, with a reduction of 3.4 points at 24 months, resulting in a total reduction of 11.4 points for symptoms that persisted from 6 to 24 month. The impact of xerostomia remained relatively stable over time. Other toxicities reduced QoL ranging from less than 1 point for physician-rated loss of taste, xerostomia and sticky saliva at 6 and 12 months, to 4.4 and 4.5 points for patient-rated moderate to severe hoarseness and aspiration at 24 months. Toxicity weightings were added to the NTCP models and combined in the TCF to calculate the comprehensive impact on QoL for each single treatment plan.

Abstract 197; Table 1

Patient-Rated Toxicities	Physician-Rated Toxicities
Moderate-Severe Xerostomia	Dysphagia grade 2-4
Severe Xerostomia	Dysphagia grade 3-4
Moderate-Severe Hoarseness	Xerostomia grade 2-4
Moderate-Severe Sticky Saliva	Sticky Saliva grade 2-4
Moderate-Severe Loss of Taste	Loss of Taste grade 2-4
	Aspiration grade 2-4

Conclusion: The impact of physician-rated and patient-rated toxicities on QoL can be quantified in a TCF. The TCF can be used to optimize radiation treatment plans, compare plans and select the plan which is expected to provide the optimal spectrum of toxicities resulting in the best quality of life for individual patients.

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Prostate Cancer Anxiety in Survivors, Results from a Population-Based Cohort

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Purpose/Objective(s): Anxiety in cancer survivors can be harmful because it is associated with depression, poorer adherence to medical treatment, poorer treatment outcomes, and higher rates of mortality. However, anxiety in prostate cancer survivors has not been well-studied and is not well understood.

Materials/Methods: In the only modern, fully-prospective, population-based cohort, 951 men diagnosed from 2011-13 with localized prostate cancer were enrolled throughout the state in collaboration with the North Carolina state cancer registry. All patients were prospectively followed, and anxiety assessed using the validated Memorial Anxiety Scale for Prostate Cancer (MAX-PC); 11 items assess prostate cancer anxiety with total score range from 0 (none) to 33 (most anxiety). Multivariable analysis using generalized estimating equations assessed patient and diagnostic factors associated with anxiety.

Results: Diversity of the cohort reflects population-based recruitment: 26% non-white, 30% high school education or less, 23% rural. Median age 65. Mean anxiety score for the entire cohort was 6.1 (out of maximum 33) at 12 months, 5.1 at 24 months, 4.8 at 36 months, and 5.0 at 48 months. Mean score at 48 months by subgroup is summarized in Table. Multivariable analysis showed that longer follow-up (48 vs 12 months, estimate -1.1, $p<.01$), lower risk cancer (low vs high, estimate -1.5, $p<.05$; intermediate vs high, estimate -1.5, $p=.04$), and older age (estimate -0.1 per year, $p<.01$) were associated with less anxiety. Conversely, non-white men (vs white, estimate 2.4, $p<.01$) and lower education (vs college, estimate 2.1, $p<.01$) were associated with higher anxiety. Active surveillance patients had borderline higher anxiety compared to RT (estimate 1.0, $p=.068$).

Conclusion: Anxiety in prostate cancer survivors decreases over time, but certain subgroups—especially minority patients and those with lower educational attainment—experience higher anxiety than other subgroups at 48 months follow-up. While disparities in prostate cancer treatment and survival are well-described, to our knowledge this is the first study demonstrating disparity by race and education in mental well-being in prostate cancer survivors.

Abstract 198; Table 1 Mean Prostate Cancer Anxiety score at 48 months by subgroup (range 0–33)

Treatment Modality	Active surveillance	5.6
	Radical prostatectomy	4.9
	RT	4.6
Race	White	4.2
	Non-white	7.4
NCCN Risk Category	Low	5.1
	Intermediate	4.6
	High	5.3
Education	High school or less	6.4
	College or higher	4.3