A generic normal tissue complication probability model for predicting radiation-induced esophagitis observed in non-small cell lung cancer patients

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Introduction

Given the different dose distribution of photon and proton radiotherapy, the normal tissue complication (NTCP) model developed in one modality may not be suitable for predicting NTCP in patients treated using another modality. A generic NTCP model that fits with both patient cohorts will help physicians to choose between proton radiotherapy and photon radiotherapy for patients according to the estimated clinical benefits of the different modalities.

Aim

To develop a generic normal tissue complication probability model for predicting radiation-induced esophagitis (RE) observed in non-small cell lung cancer patients receiving either photon or proton radiotherapy.

Methods

- Patients characteristic

  221 patients received intensity-modulated radiation therapy

  103 patients received passive-scattering proton therapy
- Endpoint of the study

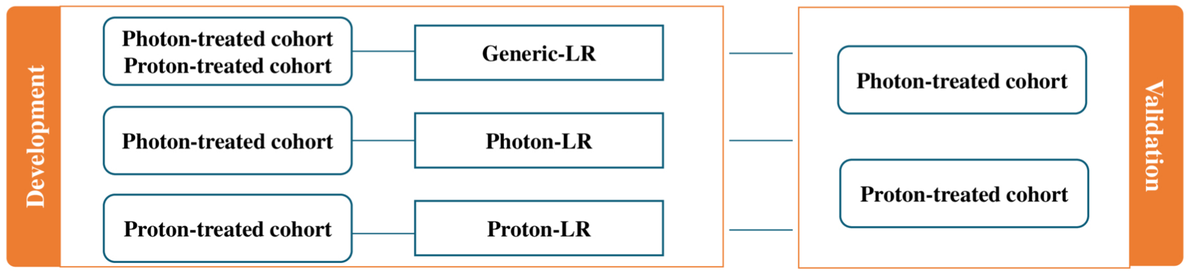
  Grade ≥2 RE within 6 months from the first treatment
- Modeling method and variable selection

  Multivariable logistic regression using the LASSO penalized method
- Performance evaluation

  Discriminative ability---AUC

  Calibration-Hosmer–Lemeshow test

Methods



Results

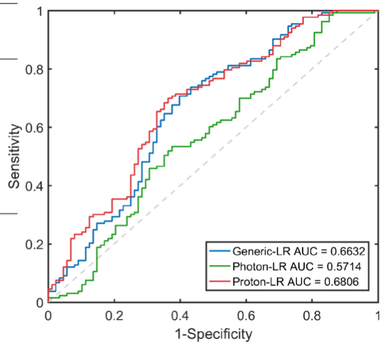
- Grade 2 or higher RE was observed in 184 (56.79%) patients (photon: 133 (60.18%), proton: 51 (49.51%)), and no grade 4-5 was reported.
- The Generic-LR shows a better performance than the cross-modality performance of Photon-LR and Proton-LR.
- The predictive performance of Generic-LR is comparable to Photon-LR in photon-treated cohort while is worse than Proton-LR in proton-treated cohort.

Table 1 Predictors and goodness-of-fit of Generic-LR, Photon-LR, and Proton-LR models

Model	Predictors	Goodness-of-fit test* on Photon-treated cohort	Goodness-of-fit test* on Proton-treated cohort
Generic-LR	D_{max}, V45, V75	$\chi^2 = 13.91$ ($p = 0.13$)	$\chi^2 = 12.41$ ($p = 0.19$)
Photon-LR	D_{max}, V40, V45	$\chi^2 = 9.38$ ($p = 0.40$)	$\chi^2 = 11.49$ ($p = 0.24$)
Proton-LR	D_{max}, V5, V55, V75	$\chi^2 = 154.33$ ($p < 0.001$)	$\chi^2 = 8.43$ ($p = 0.49$)

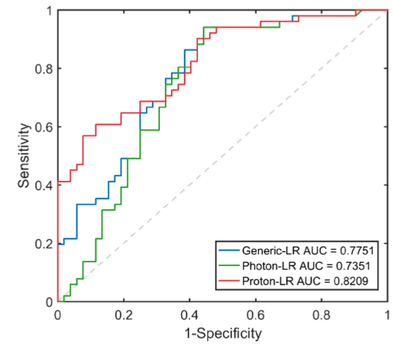
* A p value greater than 0.05 indicates significant good agreement between predicted and observed toxicity

AUC in photon-treated cohort



Results

AUC in proton-treated cohort



Conclusion

- A generic NTCP model including D_{max},V45, and V75 to predict grade ≥2 RE in NSCLC patients showed good predictive performance both in patients receiving photon and proton radiotherapy.
- Proton-specific NTCP model is recommended for better prediction in proton-treated cohort.

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