ESTRO MOBILITY GRANT (TTG) REPORT

Title of the report: External validation of image biomarker outcome prediction models

HOST INSTITUTE:
MD Anderson Cancer Center, Houston, Texas, United States

DATE OF VISIT:
16-26 July 2018

Lisanne van Dijk MSc.

Post-doc at Radiotherapy department at the University Medical Center Groningen

Groningen, the Netherlands

Email: l.v.van.dijk@umcg.nl

Head and neck cancer (HNC) affects around 650.000 people worldwide, and accounts for 350.000 cancer related deaths annually [1]. Currently, radiotherapy outcome prediction models are not actively employed, and treatment decisions are based on protocolised guidelines. If treatment outcome prediction would be improved, the field of radiotherapy can move towards more personalised treatment strategies, instead of a “one-size-fits-all” approach.

In recent years, several studies have demonstrated that medical imaging data can be used to improve the prediction of treatment outcomes [2–7]. Image data is quantified into so-called image biomarkers that represent intensity, texture and geometric properties of tissue from a specific volume of interest. Prediction model can be developed with these image biomarkers as potential variables. We showed previously that image biomarkers of the tumour and pathological lymph nodes, obtained from pretreatment CT-images, were able to predict treatment outcome measures better than clinical variables, such as age, tumour stage and patient performance score [2,6]. However, the local-regional prediction models remain to be validated in a large external validation cohort, before they can be utilized in clinical personalised treatment strategies. In other words, validated local-regional prediction models could identify the patients at risk of treatment failure, ultimately allowing to guide treatment decision making.

The main aim of the visit was to assemble a combined dataset to externally validate and/or update recently developed image biomarker models that predict treatment outcome. Combining forces between MD Anderson Cancer Center (MDACC) and University Medical Center Groningen (UMCG) is compelling, not only due to the necessary increase of statistical power, but also due to the difference in HNC patient’s population.

The first step was to establish the important differences between treatment and demographics, as they are crucial for solid model development and interpretation. During the visit, we reviewed the different patient demographics of the radiotherapy population, see Figure 1-left. Not surprising, the majority of the patients in MDACC are oropharyngeal HPV positive patients, which is not the case for UMCG population, where the larynx carcinomas are more prevalent (Figure 1-right). Another observation was the difference in treatment: 1) CTV definitions were done in MDACC based on anatomical regions, whereas UMCG uses the 1 cm GTV-CTV expansion, 2) Oral cavity patients are all post-operatively treated in MDACC, yet in UMCG also with primary RT, 3) in the UMCG, if the HNC patient receive systemic treatment it is always concomitant, this varies in MDACC, 4) obviously, in MDACC the insurance policies have a large influence on treatment decision making. For the imaging, although currently changing, planning CT were not made with intravenous contrast in MDACC. Since this influences the image biomarker values, contrast enhanced diagnostic scans are used, yet tumours delineations all need to be curated. All these observations are essential in understanding and developing image biomarker prediction models, as they can have a large impact on the analyses. Since model validation is currently ongoing, we do not have the final results of the research yet.

Besides working on the research described above, the visit was also very valuable in order to observe the clinical practice of HNC proton therapy. Whereas the UMCG introduced radiation with proton therapy at the start of this year, MD Anderson has been doing this since 2006. If models are successfully validated, we are planning a clinical trial to investigate whether image biomarker models can select patients for proton therapy.

Dr. Fuller and his lab have been very supportive of my visit. Thank y'all, looking forward to our continuing research collaboration. Lastly, I like to thank the ESTRO for their financial support, it has been an very insightful visit.

Lisanne van Dijk MSc.

Post-doc at Radiotherapy department at the University Medical Center Groningen

Groningen, the Netherlands

l.v.van.dijk@umcg.nl

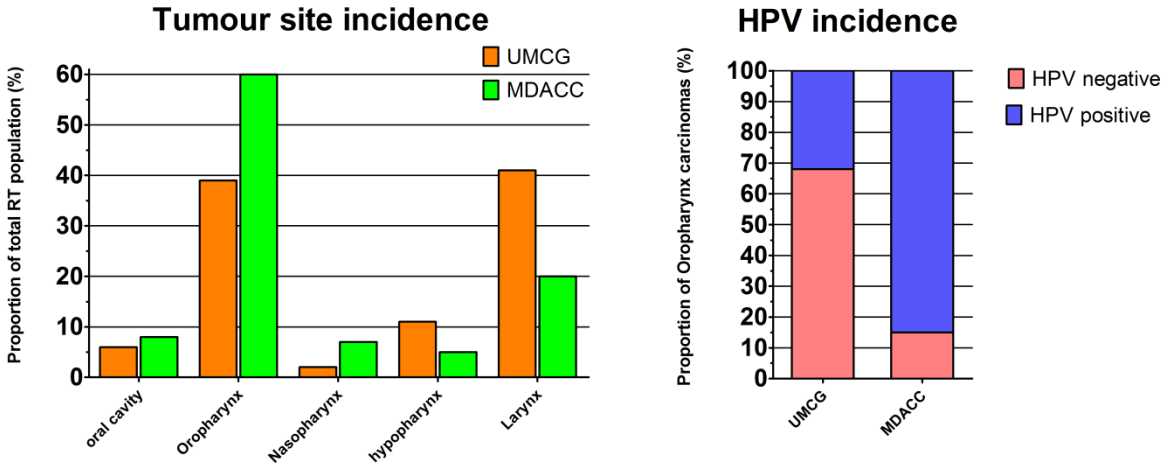

Figure 1. Left) Initial estimate of tumour site distribution for both UMCG (orange) and MDACC (green). Right) HPV incidence in oropharyngeal tumours in UMCG and MDACC.

Figure 2. The Head and Neck Quantitative Imaging Working Group, summer students and I (in green).

References

[1] Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-tieulent J, Jemal A. Global Cancer Statistics, 2012. CA a Cancer J Clin 2015;65:87–108. doi:10.3322/caac.21262.

[2] Zhai T-T, van Dijk L V, Huang B-T, Lin Z-X, Ribeiro CO, Brouwer CL, et al. Improving the prediction of overall survival for head and neck cancer patients using image biomarkers in combination with clinical parameters. Radiother Oncol 2017:256–62. doi:10.1016/j.radonc.2017.07.013.

[3] Vallières M, Kay-Rivest E, Perrin LJ, Liem X, Furstoss C, Aerts HJWL, et al. Radiomics strategies for risk assessment of tumour failure in head-and-neck cancer. Sci Rep 2017;7:1–14. doi:10.1038/s41598-017-10371-5.

[4] Aerts HJWL, Velazquez ER, Leijenaar RTH, Parmar C, Grossmann P, Cavalho S, et al. Decoding tumour phenotype by noninvasive imaging using a quantitative radiomics approach. Nat Commun 2014;5. doi:10.1038/ncomms5006.

[5] Kumar V, Gu Y, Basu S, Berglund A, Eschrich S a, Schabath MB, et al. Radiomics: the process and the challenges. Magn Reson Imaging 2012;30:1234–48. doi:10.1016/j.mri.2012.06.010.

[6] Zhai T, Langendijk J, van Dijk L, Halmos G, Witjes M, Oosting S, et al. Prognostic Value of CT-based Image-biomarkers for Treatment Outcomes of Head and Neck Cancer Patients. Int J Radiat Oncol Biol Phys 2018;Submitted.

[7] Caudell JJ, Torres-Roca JF, Gillies RJ, Enderling H, Kim S, Rishi A, et al. The future of personalised radiotherapy for head and neck cancer. Lancet Oncol 2017;18:e266–73. doi:10.1016/S1470-2045(17)30252-8.