The Role of a Decision Tree Model to Predict Weight Loss Following Radiotherapy in Head and Neck Cancer Patients

Z. Cheng1, M. Nakatsugawa1, A. P. Kiess1, S. P. Robertson1, J. Moore1, M. Allen1, S. Afonso1, A. Choflet1, K. Sakaue3, S. Sugiyama3, J. W. Wong1, T. R. McNutt1, and H. Quon1

1Johns Hopkins University, Baltimore, MD, 2Toshiba America Research, Inc., Baltimore, MD, 3Toshiba Medical Systems Corporation, Otawara, Japan

Purpose/Objectives

- The QOL*1 of the irradiated head and neck cancer (HNC) patient can be significantly affected by toxicities leading to weight loss
- To determine the predictors for weight loss based on the experience of similar previously treated patients
- To develop a real-time clinical decision support system to predict and reduce toxicities with a learning health system (LHS) model

Materials/Methods

- Oncospace: an integrated analytic relational database that systematically captures clinical outcome results and all aspects of a radiotherapy treatment plan.
- Retrospective analysis was undertaken using structured data elements (SDEs) that were prospectively acquired during routine clinical care
- Data
  - 391 HNC patients from 2007 to 2014 (Table 1)
  - 3,015 clinical and dosimetric variables
    • diagnostic ICD-9 code
    • planned DVH*2 at 1% volume increments
    • OVH (Overlap Volume Histogram): distance b/w PTV*3 and OARs*4 on CT Image
    • NCI-CTCAEv4.0 toxicity and QOL

Table 1 – Demographic data (n=391)

<table>
<thead>
<tr>
<th>Variable</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset Age, ≥60</td>
<td>169 (43%)</td>
</tr>
<tr>
<td>Male</td>
<td>306 (78%)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>187 (48%)</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>261 (67%)</td>
</tr>
<tr>
<td>T stage, ≥T3</td>
<td>114 (29%)</td>
</tr>
<tr>
<td>N Stage, ≥N2</td>
<td>169 (43%)</td>
</tr>
<tr>
<td>Site, pharynx</td>
<td>126 (32%)</td>
</tr>
</tbody>
</table>

Materials/Methods (Cont.)

- Method
  - Weight loss of 5kgs or more at 3 months post-RT was predicted by the Classification and Regression Trees (CART)
  - Two prediction models for incremental datasets (Fig. 1)
    1) at RT planning without variables during RT
    2) at the end of RT with variables during RT

Results

- Weight loss predictors at RT planning (Fig. 2)
  • AUC*5 0.773
  • Sensitivity 0.766, PPV*6 0.426
  • Predictors:
    • (1: Dosimetry) dose to masticatory muscle, larynx, parotid
    • (2: Diagnosis) ICD-9 code
    • (3: Patient) age

Results (Cont.)

- Weight loss predictors during treatment (Fig. 3)
  • AUC 0.839
  • Sensitivity 0.988, PPV 0.467
  • Predictors:
    • (1: QOL) patient reported oral intake
    • (2: Diagnosis and staging) ICD-9, N stage
    • (3: Dosimetry) dose to larynx, parotid
    • (4: Toxicity) skin toxicity, nausea, pain
    • (5: Geometry) minimum distance between PTV and larynx

Conclusion

- Systematic capture of SDEs and data-mining tools facilitated a decision-support analysis tool for weight loss based on past similarly treated patients
- The two prediction models at RT planning / treatment
  • identified the importance of Patient Reported Outcome
  • showed the potential for a real-time decision-support (e.g. prophylactic feeding tube placement)
- Future work: evaluating models in the clinical settings; imaging features might be helpful to improve PPV