Feasibility of an Assisted Chart Review for Assessing the Development of Radiation Pneumonitis

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INTRODUCTION

- Manual chart review is a labour-intensive process that requires a significant time investment for clinical researchers.
- Natural Language Processing (NLP) is a computer model that can manipulate documents containing narrative text and speech (also known as natural language) and export it in a structured format for analysis (1).
- Using a NLP computer algorithm as a tool could enable a chart review to be completed in less time with less human resources.

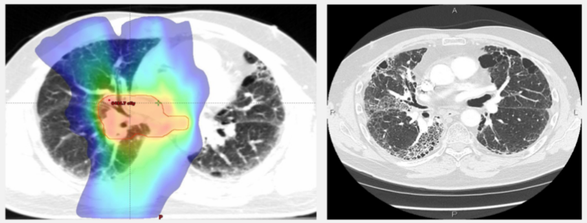

Figure 1: Radiation therapy planning CT for lung cancer patient (left). The same patient's three month follow up CT image showing radiologic changes of Radiation Pneumonitis in the radiation field (right).

- Of the lung cancer patients treated with radiotherapy (RT), it is expected that 10-20% will develop moderate to severe radiation pneumonitis (RP) (2-4).
- The focus of identification in this study is on the clinically significant cases of RP ≥ grade 2.

RP Severity	Common Terminology Criteria for Adverse Events (CTCAE) v5.0 Definition
Grade 0	No RP present
Grade 1	Asymptomatic; clinical or diagnostic observations only; intervention not indicated
Grade 2	Symptomatic; medical intervention indicated; limiting instrumental activities of daily living
Grade 3	Severe symptoms; limiting self care activities of daily living; oxygen indicated

Table 1: RP grading based on CTCAE v5.0 (5).

AIM

The objective was to evaluate the feasibility and accuracy of an assisted chart review program to identify lung cancer patients who developed radiation pneumonitis after receiving curative radiotherapy.

METHOD

- In the manual chart review, RP diagnosis and grading was recorded using Common Terminology Criteria for Adverse Events (CTCAE) v5.0 (5).
- From the charts of 50 sample patients, a total of 1413 clinical documents (clinical notes and radiology reports) were extracted for review. The in-house computer program (script) was built using the Natural Language Toolkit (NLTK) Python platform. Patient charts were extracted from the Cancer Agency Information System (CAIS) and subsequently formatted into ASCII text files to be compatible with the script. Python version 3.7.2. was used to run the assisted chart review algorithm.
- The terms "pneumonitis", "radiation pneumonitis" and "fibrosis" were used as keywords for the assisted chart review.
- The output of the computer program was a list of the full sentences containing the key terms, along with the document ID's and dates from which these sentences were extracted. The computer program results were then compared to a manual chart review to determine accuracy.

Study Population: patients who received curative RT for stage II-III lung cancer from January 1, 2013 to December 31, 2015 at BC Cancer Kelowna.

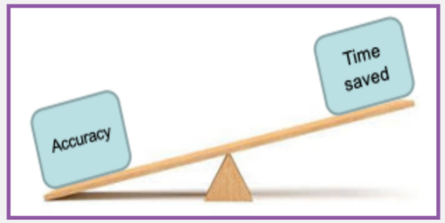

Figure 2: The key for automated chart review is the balance between script accuracy (no disease cases missed) versus the amount of time saved by confidently eliminating true RP grade 0 patients in the review.

RESULTS

- The algorithm was able to ascertain 23 out of 25 patients who developed RP ≥ grade 1 (sensitivity = 0.92, 95%CI:0.74-0.99; specificity = 0.36, 95%CI:0.18-0.57). Furthermore, the algorithm was able to correctly identify all 9 patients with RP ≥ grade 2 (sensitivity = 1.0, 95%CI: 0.66-1.0; specificity = 0.27, 95%CI:0.14-0.43). These patients had clinically significant symptoms.
- The utility of the program in this study would be avoiding unnecessary manual review of 22% of the non-RP patients, including their 198 (14% total) electronic documents. It will also streamline the rest of the manual review as key sentences with the key terms were identified, allowing for faster manual review of the remaining patient charts.
- AUC (the area under the receiver operating characteristic (ROC) curve) for all grades of RP patients was 0.64 (95%CI:0.49-0.77). ROC contrast test against the null value 0.5 gives a p-value of 0.0129, indicating the algorithm was successful in distinguishing patients with RP from those without RP.

RP Severity	Correctly Identified
Grade 0	9/25
Grade 1	14/16
Grade 2	7/7
Grade 3	2/2

Table 2: Script results looking at the ability to distinguish between patients with RP grade 0 and RP ≥ grade 1.

(6)

The manual chart review: Average 30 documents per patient (R: 15 – 150). Time spent on one patient's chart ~ 25 min. 25 min/pt x 50 pts = **20.8 hours**

The assisted chart review: The algorithm ran through the 1413 clinical notes and exported the results in **under 5 minutes**

		Manual Chart Review		
		health (RP grade 0)	disease (RP grade ≥ 1)	Total
Script Prediction	health (RP grade 0)	9	2	11
	disease (RP ≥ grade 1)	16	23	39
	Total	25	25	50

Table 3: Script results for identification between patients with RP grade 0 (health) versus RP ≥ grade 1 (disease).

		Manual Chart Review		
		health (RP ≤ grade 1)	disease (RP ≥ grade 2)	Total
Script Prediction	health (RP ≤ grade 1)	11	0	11
	disease (RP ≥ grade 2)	30	9	39
	Total	41	9	50

Table 4: Script results looking at the ability to distinguish between patients with RP ≤ grade 1 (health) and RP ≥ grade 2 (disease).

CONCLUSIONS

- Assisted chart review program saves chart review time by:
  1) Complete elimination of patient charts identified with grade 0 RP
  2) Extracting key sentences from patients charts that allows the reviewer to grade patients RP severity without reading the rest of their chart
- Limitations: (1) Current high false positive rate leads to unnecessary chart review of RP free patients. (2) Upon further review, the two patients with grade 1 RP that the script missed were found to be due to human error in the manual chart review rather than script error. Changes in data analysis to include review of false negative cases will be added in subsequent studies with the assisted chart review program.
- This feasibility study showed that the NLP computer program was able to assist with the identification of patients who developed RP after curative radiotherapy.
- This work has a potential to improve future clinical research as the computer programs can perform chart review in a more time and effort efficient manner compared to the traditional manual chart review.

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