Radiation therapy (RT) is one of the most common methods prescribed to treat cancer. Currently, designing personalized treatment plans has not been achieved since tools needed to monitor and evaluate individual patient responses to radiation have not been developed.

Raman spectroscopy, an optical spectroscopy technique, has been utilized to investigate radiation-induced cellular responses in H460, MC47, and LNCaP cancer cell lines across different dose levels and times post-irradiation. Previously, principal component analysis (PCA) was applied to analyze the cellular Raman data acquired by our group, but it only extracted limited biological information on glycogen. To improve the data analytical result, non-negative matrix factorization (NMF) was applied in the current study and glycogen-like and lipids-like component bases were decomposed. The variations in glycogen and lipids levels were observed by plotting NMF generated glycogen and lipid scores. The cancer cell lines were clustered into radiosensitive and radioresistant groups based on glycogen and lipid-like bases. A lipid phenotype investigation was also conducted based on the lipid-like bases decomposed individually on three cell lines with non-negative least squares (NNLS). Qualitative differences in lipids weights for each lipid-like basis may indicate lipid phenotype differences among the three cancer cell lines. Results from the current study demonstrate that combining NMF with Raman spectroscopy can facilitate Raman data analysis to monitor cellular responses induced by ionizing radiation.

Poster Reception – 03

Simple data imputation for missing feature values in binary classification

Avishek Chatterjee, Henry Woodruff, Martin Vallieres, Jan Seuntjens, McGill University, Maastricht University Medical Centre, McGill University Health Centre

Purpose: Outcome prediction is affected by incomplete data for predictor variables. Using simulation, we investigate two data imputation methods for three dataset sizes and seven classifiers to thoroughly characterize this issue. **Methods:** To mimic predictive variables (e.g., radiomic or clinical), five features were simulated as the union of two Gaussian histograms. Simulation choices were made such that correlation between two features varied between $\approx$ 0–0.5, and correlation between a feature and the outcome varied between $\approx$ 0.45–0.7. Training and testing sets were of equal size, both balanced. ML tools included Naive Bayes, linear discriminant, SVM, KNN, decision tree, and random forest (RF). The missing fraction (MF) of training set data for each feature was set to a certain value common to all features for a given iteration of the experiment (MF = 0.1, 0.2... 0.5). **Results:** The baseline accuracy (training and testing) was $\approx$ 1 for all classifiers. In the training set, median imputation outperformed MC imputation for all classifiers except RF, the difference increasing with MF. For the testing set (no missing data), for N = 200 and N = 20000, there was virtually no performance loss for non-tree classifiers. For N = 50, there was marginal accuracy loss depending on classifier type (e.g., only 2% for KNN). RF suffered no performance loss in training but did in testing, the discrepancy reducing with increasing N (bias-variance tradeoff). **Conclusions:** Median imputation is adequate for features modeled as sum of two Gaussians. The results need to be validated on clinical data, where features may deviate from this behavior.

Poster Reception – 04

Implementation of a visually-monitored voluntary Deep Inspiration Breath Hold (vDIBH) radiotherapy technique for treatment to the left breast or chestwall

Erin Barnett, Tyler Pestill, Cari Bradley, Leslie Proctor, Douglas Moseley, Daria Comsa, Stronach Regional Cancer Centre, Southlake Regional Health Centre, Princess Margaret Cancer Centre, University of Toronto

Purpose: At our centre patients undergoing left breast radiotherapy are offered a moderate Deep Inspiration Breath Hold (mDIBH) technique, using a commercial system, to reduce the heart volume irradiated. Some patients are unable to tolerate mDIBH due to discomfort caused by the nose clip and snorkel required. This work describes development of a low cost visually-monitored voluntary DIBH treatment technique. **Materials and methods:** Simulation and tangent treatment planning are performed according to department protocol for 10 free breathing patients and 10 mDIBH patients who consent to participate. To monitor patient position during treatment delivery, marks are made on patients' skin after image guidance is performed at the level of the lateral laser. In cases where the lateral laser is blocked by the gantry at the lateral gantry angle, the marks are also made at the posterior field edge. Video recordings during treatment delivery using the in-room CCTV are used to monitor the patient position with respect to the lasers or posterior field border. Cine mode EPID images are also acquired during delivery. **Results:** To date, treatment delivery of 10 mDIBH patients has been recorded with CCTV and EPID cine mode during 103 tangent and 20 boost deliveries. Treatment delivery for 5 free breathing patients has been recorded with CCTV and EPID cine mode for a total of 63 tangent and 14 boost deliveries. **Conclusions:** A workflow using existing equipment has been established that will support visually-monitored voluntary Deep Inspiration Breath Hold treatment of left breast or chestwall.

Poster Reception – 05

A Planning Study: Escalating the Single Fraction Monotherapy Dose for HDR Prostate Brachytherapy

Eric Sabondjian, Raxa Sankreacha, Jasper Yuen, Sarah Rauth, Carlo Fidani Regional Cancer Centre

Introduction: Cancer Care Ontario guidelines state that a High Dose Rate (HDR) brachytherapy boost combined with External Beam Radiotherapy should be offered to eligible intermediate to high risk prostate cancer patients. Studies looking at performing HDR monotherapy for a subset of these patients are reporting favorable results. The most common dose fractionating is 27 Gy/2, but this requires two separate needle insertions. A more tolerable and less resource intensive approach may be using a single fraction. A dose fractionation of 19 Gy/1 has been studied, giving conflicting results. In theory, the lower alpha/beta ratio of the prostate compared to the normal tissues surrounding it, makes it ideal for dose escalation studies. In this study, we are exploring the planning feasibility of escalating the single fraction HDR brachytherapy dose to the entire prostate. **Methods:** This study looked at planning a single fraction dose of up to 22 Gy to the prostate. A biologically equivalent dose (BED) calculation for the prostate, urethra, and rectum was done to compare the escalating dose to the accepted 27 Gy/2 fractionation scheme. The BED calculations were used to plan 5 prostate cases to see the feasibility of delivering a higher single fraction dose to the prostate. **Results:** We were able to go as high as 22 Gy before the high dose volume and urethra dose constraints went over our tolerance levels by <2%. Compromising coverage surrounding the urethra and using more needles can help to meet tolerance levels. **Conclusion:** This planning study showed that a > 19 Gy single fraction dose is feasible.

Poster Reception – 06

Evaluation of the secondary neutron fluence spectra, during high energy radiation therapy, using a passive Nested Neutron Spectrometer (NNS) with gold activation foil.

Felix Mathew, Cornelia Chilian, Logan Montgomery, John Kildea, McGill University, Polytechnique Montreal, McGill University Health Centre

Purpose: Radiation therapy with high-energy photons poses a risk of secondary malignancies to patients due to photoneutrons generated in the linac head. The risk associated with these neutrons also raises safety concerns for the personnel involved. This study was performed to evaluate the neutron fluence spectra, generated during radiotherapy, using a passive Nested Neutron Spectrometer™ (NNS, Detec Inc, Gatineau, Quebec) with gold activation foils as thermal neutron detectors. **Methods:** The measurement involved two phases; activation of gold foils through irradiation and activation analysis. The passive NNS with gold foil was irradiated with a 15 MV beam at 600 MU/min for 15 mins, and was repeated for all detector configurations. The radioactivity of the gold foil was then analysed using a HPGe spectrometer. The measured activities were then iteratively unfolded using the Maximum-Likelihood Expectation Maximization (MLEM) algorithm to obtain the neutron fluence spectra generated during the irradiation. For this purpose, the response functions for the NNS and gold foils were generated using Monte Carlo simulation. **Results:** The response functions obtained for different detector configurations show that the sensitivity of the detector drifts towards higher neutron energies as the thickness of the moderator around the thermal neutron detector increases, as expected. The unfolded neutron fluence spectra at the point of measurement are obtained, and the fast neutron peak around 1 MeV can be observed in the spectrum. **Conclusions:** The preliminary results shows that the neutrons were primarily of about 1 MeV at the location of measurement.