Factors and systems engineering. Through the principles of human factors and system engineering, this study seeks to understand the relationship of radiation therapy associated hardware and software incidents, practitioners, their environment, and radiation technology.

Methods and Materials: A retrospective analysis of incidents occurring from April 2013 September 2015 within a major metropolitan radiation therapy centre was performed. Radiation therapy (RT) related incidents were analyzed using two frameworks. Framework I classified incident types as software, hardware, or not applicable. Framework II applied the Human Factor Analysis and Classification System (HFACS), which was used to determine human and systematic attributes to incident causation.

Results: One hundred and seventy-six incidents were identified to be RT-related. The application of Framework I indicated 44.8% and 15.3% involved the use of RT software and hardware respectively. A thematic analysis was completed using Framework II in relation to the classifications within Framework I. An examination of the major classes of software incidents showed, 26.70% of the total incidents were software transcription-related. A review of the major classes of hardware incidents identified that 9.99% of total incidents were due to faults of the RT device and 5.11% were attributable to operator error.

Conclusions: The addition of new technology and practices has the benefit of improved outcomes for patients. However, it also serves as a double edged sword that may potentially increase the risk of medical error and patient harm. Applying the principles of human factors and systems engineering provides an opportunity to identify incidents and leverage software and hardware design to potentially mitigate these errors, ultimately enhancing patient safety and quality of care.

58 ACUTE QUALITY OF LIFE CHANGES AFTER STEREOTACTIC ABLATIVE RADIOTHERAPY FOR LIVER METASTASIS: A PROSPECTIVE COHORT ANALYSIS

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Purpose: The use of stereotactic ablative radiotherapy (SABR) to treat metastatic disease is increasing. There is a paucity of prospective quality of life (QoL) data published for liver SABR. Moreover reported series often include hepatocellular carcinoma. Herein we report QoL after SABR in patients with liver metastases (LM).

Methods and Materials: A single-institution prospective cohort study was undertaken to measure the acute changes in QoL after SABR. Patients with Child-Pugh A liver function, any solid primary tumour with 1-3 LM treated with SABR were eligible. Doses of 30-60 Gy in 3-5 fractions were delivered. Indications of SABR included oligometastases and oligoprogression. Prospective QoL was measured using the European Organisation for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire-Core 15 Palliative (QLQ-C15) and the EORTC QLQ-liver metasteses (QLQ-LM21) validated questionnaires at baseline, 1 week of treatment, last day of treatment, then one, six and 12 weeks after treatment completion. In addition the functional living index-emesis (FLIE) was collected at baseline, first week of treatment, last day and one week after completion. Univariable linear mixed modelling was performed to assess changes of QoL over time. Multivariable linear mixed modelling was performed to determine predictors of QoL changes after adjusting for time. A minimally important difference (MID) in QoL was defined as a change of ≥10 points compared to baseline for each follow up visit with ≥10-point decrease representing worse QoL. A two-tailed p-value ≤0.05 was considered statistically significant.

Results: Sixty patients (32 males) were included. Mean age at time of treatment was 67±13 years. Median BED10 was 100 Gy (58-180). The most common primary cancer was colorectal in 42% of the patients followed by other gastro-intestinal malignancies in 17% and breast in 15%. Oligometastasis was the treatment indication in 55% of patients. Actuarial overall survival at one year was 79%. The global health score measured by QLQ-C15 was significantly worse at treatment completion (p = 0.001), 1w (p = 0.003) and 6w (p = 0.002) after SABR but recovered by three months (p = 0.124). Nausea, constipation and fatigue were also worse at treatment completion (p = 0.05) but recovered one and six weeks after treatment. The FLIE questionnaire showed consistent findings for nausea with significant deterioration at the end of treatment (p < 0.001). The majority of patients reported stable or better QoL at three months for all domains in the three questionnaires. On multivariable analysis, uninvolved liver was a significant predictor of worse fatigue (p = 0.009) and anorectite (p = 0.004). Male gender, left colectomy and small bowel max dose was a predictor of constipation (p = 0.026).

Conclusions: SABR offers a non-invasive mean of ablating liver metastases with minimal impact on QoL. Our data suggests that some dosimetric parameters are predictors of worse QoL outcome. Longer follow up and efficacy data are needed.

59 PATIENT SELF-ASSESSMENT OF BOWEL FUNCTION BEFORE AND AFTER RADICAL CHEMORADIOThERAPY FOR ANAL CANCER

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Purpose: Anal canal cancer (ACC) and associated treatment can adversely impact quality of life, with bowel control and function being key considerations. Standard treatment for localized ACC consists of combined chemoradiotherapy (CRT). Previous studies examining treatment-related late bowel toxicity have not adequately assessed baseline function, and any bowel dysfunction is often attributed to previous treatment. In this single-institution study, we aimed to evaluate patient self-assessed bowel function and associated symptoms at baseline and after radical CRT.

Methods and Materials: Fifty-four patients with ACC scheduled for radical CRT with mitomycin C and 5-fluorouracil were recruited. Median patient age was 57 (range 37-83); 36 (66.7%) were female; 26 (48.1%) had AJCC Stage II disease, 9 (18.5%) had Stage IIIA, and 19 (35.2%) Stage IIIB. Patients completed the European Organisation for Research and Treatment of Cancer (EORTC) QLQ-C30 and QLQ-CR29 quality of life questionnaires at baseline, midpoint and end of CRT, at six and 12 weeks, and six, nine, 12, 24, and 36 months post-completion of CRT. Patients reported scores of leakage, constipation, diarrhea, stool frequency, flatulence, and embarrassment on a scale from 1-4 indicating the degree of the problem, with a score of 1 representing “not at all”, and 4 representing “very much”. Patient scores were compiled for each time point and compared (Fisher’s exact test).

Results: At baseline, 9.8% of patients had leakage scores of 3-4, compared with 11.1% 12 months post-CRT (p = 1.0). 13.4% had constipation scores of 3-4 at baseline, compared with 5.3% at 12 months (p = 0.29). 3.8% had diarrhea scores of 3-4 at baseline, compared with 15.8% at 12 months (p = 0.066). 17.7% had stool frequency scores of 3-4 at baseline, compared with 19.4% at 12 months (p = 1.0). 17.7% had flatulence scores of 3-4 at baseline, compared with 19.4% at 12 months (p = 1.0). Finally, embarrassment scores of 3-4 were reported by 13.7% of patients at baseline compared with 11.1% of patients at 12 months (p = 1.0). At a median follow up time of 26.6 months (range 0-66.4), nine patients (16.7%) had a colostomy, 10 (18.5%) had disease recurrence, and seven (13.0%) had died.

Conclusions: In our population, bowel function including fecal incontinence, stool frequency, flatulence, and embarrassment were comparable 12 months after completion of CRT compared with baseline. Diarrhea increased over this time period, while constipation decreased, although not reaching statistical
significance in either case. Bowel dysfunction in ACC is frequently attributed to treatment-related toxicity, however our data support the hypothesis that dysfunction is frequently multifactorial, including disease, comorbidity, and psychosocial factors in addition to treatment factors, and that adequate baseline assessment of function is essential prior to CRT.

60 OUTCOMES OF ESOPHAGEAL CANCER PATIENTS TREATED WITH TRIMODALITY THERAPY IN A COMMUNITY HOSPITAL

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Purpose: Chemoradiation (CRT) followed by surgery has become the standard of care for the treatment of localized esophageal carcinoma. The rationale for this study was to examine survival outcomes and Quality of Life (QOL) in esophageal carcinoma patients treated with tri-modality therapy in a community cancer centre.

Methods and Materials: Patients identified between June 2010 and November 2015 with a diagnosis of adenocarcinoma or squamous cell carcinoma of the esophagus, Stage T1-4N0-3 (AJCC 7th Ed.) and undergoing tri-modality treatment were eligible for this prospective cohort study. QOL (EORTC QLC C30) and toxicity data (CTCAE v3.0) were collected at baseline, and four weeks, six months, and yearly post-completion of CRT.

Results: Sixty patients consented to participate. Data was collected prospectively on 40 patients from diagnosis. Data was collected retrospectively for 20 patients diagnosed between June 2010 to February 2013 when consented at time of follow up, then followed prospectively thereafter. Thirty-three were treated with neoadjuvant CRT with 45-50 Gy in 25 fractions with concurrent 5FU and Cisplatin and 27 patients with 41.4 Gy in 23 fractions, with carboplatin and paclitaxel (CROSS protocol). Median age was 66 years (range: 40-78) with 90% males. Median follow up was 13 months (range 2.3-53). Baseline QOL data was collected in 38 patients in the prospective group. Pathological complete response (pCR) rates were 38% for those receiving CRT with cisplatin/5FU and 22% for those treated with the CROSS protocol. Two-year overall survival (OS) and disease-free survival (DFS) was 68% and 53%, respectively with a median survival of 28 months. No significant differences were seen in DFS or OS between the two treatment regimens (p = 0.95), nor were improved outcomes associated with achieving a pCR (p = 0.17). Median time to recurrence was 16 months, with locoregional recurrence in 17%, distant in 12% and both in 5%. No association was found between baseline global QOL and OS (HR = 0.9, 95% CI: 0.6-1.4) or DFS (HR = 0.8, 95% CI: 0.3-2.4). Additional QOL data will be presented.

Conclusions: Survival outcomes in our cohort are in line with those reported in the literature, although pCR rates in our CROSS protocol group were lower compared to the CROSS study, and with short follow up pCR was not significantly associated with better survival outcomes.

61 DOES EVALUATING DOSE TO CORONARY ARTERIES IMPROVE RISK ESTIMATES FOR LATE CARDIAC TOXICITY AFTER MEDIASTINAL RADIOTHERAPY FOR HODGKIN LYMPHOMA?

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Purpose: Radiotherapy (RT) for Hodgkin lymphoma (HL) is associated with late cardiac toxicity (LCT) as a potential complication after treatment. Risk of LCT is known to increase with increasing mean heart dose, however, it is unknown whether evaluating dose to coronary substructures, such as the coronary arteries, will provide additional information to predict LCT risk. This study evaluated whether estimating dose to coronary arteries (CA) provided additional explanatory information for LCT compared to estimating whole heart dose alone.

Methods and Materials: LCT status of 599 patients receiving mediastinal RT for HL at a tertiary cancer centre between 1988-2003 was determined from medical records and with linkage to a population-based hospitalization dataset. A random sample of 125 of these patients was selected and biomechanical deformable image registration was used to reconstruct 3D heart volumes from 2D imaging using validated methods. Historical RT plans were reconstructed on the 3D CT data sets and the heart and coronary arteries were contoured to estimate dose-volume variables to these structures. Principal Component analysis (PCA) was used to compare the proportion of variation in LCT explained by dose-volume variables to the whole heart versus the heart plus CA. The contribution (loadings) of different parameters (Dmean, Dmax, Dmin, V5, V10, V20, V30) to LCT occurrence was also evaluated.

Results: Forty-four cases of LCT were seen, 30 of which were ischemic; other LCT included valvular disease, arrhythmias, pericardial disease, and heart failure. Median follow up was 10.4 years (range: 0.15 - 23.8). Median Dmean to the heart, right coronary, left anterior descending, and circumflex arteries were 24.6 Gy, 29.8 Gy, 17.3 Gy, and 27.3 Gy, respectively. Both the PCA of the heart and the heart plus CA had first components that explained > 50% of the variance in LCT, and there was no substantial improvement in explanatory power by adding CA doses in addition to whole heart doses to the PCA. Within components, no single dose-volume parameter explained a large proportion of LCT (i.e. loading > 0.5): in both whole heart, and heart plus CA models, the mean heart dose contributed most to explaining LCT (loading = 0.41 and 0.25, respectively).

Conclusions: Our results indicate that estimating dose to CA will not add significant explanatory power to predict LCT in HL survivors, compared with documenting dose to the whole heart only. LCT risk in this setting may be mostly predicted by age, sex, comorbidities, and mean heart dose. However, our study may be underpowered to detect a small contribution from dose to the CA that is distinct from whole heart dose.

62 STEREOTACTIC BODY RADIOTHERAPY FOR LIVER METASTASIS: IMPACT ON SYSTEMIC THERAPY?

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Purpose: The management of patients with distant metastasis has historically been systemic therapy (ST). However, that paradigm is shifting to individually personalized care. Stereotactic body radiotherapy (SBRT) enables non-invasive ablation of liver metastases and its use is increasing despite the lack of randomized evidence. We reviewed the outcomes of liver metastases treated with SBRT at our institution, and evaluated the impact of liver SBRT on the treatment algorithm of metastatic patients on ST.

Materials and Methods: The records of 112 patients with 149 metastatic liver lesions treated with SBRT between 2011 and 2015 were retrospectively reviewed. Indications for treatment were: oligometastatic (OM) where the objective was to eradicate all sites of disease (≤5 sites); oligoprogression (OP) where only progressing lesions were treated while other sites were stable, and dominant area of progression (DAP) where a growing or symptomatic site was treated even if most or all metastatic deposits were progressing. Lesions were treated with either a 3, 5 or 6 fraction regimen delivered every other day. All patients were evaluable for response based on contrast-enhanced CT obtained at minimum of 4 months after completion of SBRT. Local control (LC), time to liver failure (TLF), time to change ST