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ELECTIVE PELVIC NODAL IRRADIATION WITH A SIMULTANEOUS HYPOFRACTIONATED INTEGRATED PROSTATE BOOST FOR LOCALIZED HIGH RISK PROSTATE CANCER: LONG TERM RESULTS FROM A PROSPECTIVE CLINICAL TRIAL

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Purpose: To report on the long-term results of patients with localized high-risk prostate cancer treated with elective pelvic nodal irradiation (EPNI) and a simultaneous hypofractionated prostate boost along with adjuvant androgen deprivation therapy (ADT).

Materials and Methods: This was a prospective single-institution single-arm Phase II study. Patients with high-risk prostate cancer (any of cT3 disease, PSA >20 ng/mL, or Gleason score 8-10) were eligible. Patients underwent radiotherapy to a dose of 45Gy in 25 fractions to the prostate and pelvic lymph nodes with a simultaneous image-guided (matched to prostatic fiducial markers) IMRT boost of 22.5Gy to the prostate for a total of 67.5Gy in 25 fractions (2.7Gy per fraction) over five weeks. Patients were to receive ADT for two to three years. Endpoints included biochemical failure (Phoenix definition), distant radiographic failure, and overall survival. Univariate and multivariable analyses were performed to look for predictive factors. Late toxicity was assessed using CTCAE v3.0 for five years.

Results: Two-hundred thirty patients (median age 71 years) were enrolled from 2004-2010. Median follow-up was 11.2 years (IQR 8.1-12.9). Sixty-seven percent of patients had Gleason score ≥8, 44% had PSA >20 ng/mL, and 27% had cT3 disease. Median ADT duration was 30 months (IQR 21-33). Median PSA nadir was 0.02 ng/mL (IQR 0.02-0.02). Cumulative incidence of testosterone recovery (>1.7 nmol/L) was 47.6% and 77.5% at five and 10 years, respectively. Cumulative incidence of biochemical failure was 15% and 33.4% at five and 10 years, respectively. At 10 years, the cumulative incidence of distant metastasis was 16.5%, and overall survival was 76.3%. On multivariable analysis, PSA nadir >0.05 ng/mL was predictive of biochemical failure (HR 6.8, 95% CI 4-11.8, p<0.001) and development of distant metastases (HR 7.5, 95% CI 3.9-14.5, p<0.0001). PSA nadir >0.1 ng/mL (HR 5.2, 95% 2.2-12, p=0.0001) and ADT use <12 months (versus >24 months) (HR 2.3, 95% CI 1.3-3.9, p=0.004) were predictive of worse survival. The five-year cumulative incidence of any late Grade ≥3 gastrointestinal and genitourinary, toxicity was 2.3% and 7.5%, respectively.

Conclusions: This was a large prospective study evaluating EPNI and a simultaneous hypofractionated prostate boost over five weeks combined with two to three years of ADT for localized high-risk prostate cancer with very mature follow-up. Ten-year biochemical control and overall survival rates were favourable. Lower PSA nadir predicted for higher biochemical control, less distant failure, and longer overall survival. ADT duration of ≤12 months was associated with decreased overall survival.

2

POPULATION BASED PHASE II TRIAL OF STEREOTACTIC ABLATIVE RADIOTHERAPY (SABR) FOR UP TO FIVE OLIGOMETASTASES: PRELIMINARY RESULTS OF THE SABR-5 TRIAL

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Purpose: After the publication of the landmark SABR-COMET trial, concerns were raised over Grade 3-5 toxicity of stereotactic ablative radiotherapy (SABR) for oligometastases. This population-based study was designed as a bridge from Phase II to Phase III trials, while assessing the toxicity profile of SABR in a larger cohort from a provincial cancer program.

Materials and Methods: From November 2016 to July 2020, 395 patients were enrolled in this single arm, Phase II trial of SABR in patients with oligometastatic (five or fewer lesions) or oligo-progressive disease. During this period, patients were only eligible for SABR in these settings on trial within our province, and therefore this analysis is population-based, with resultant minimal selection bias in comparison to previously published SABR series. The primary endpoints were side effects and quality of life. Grade 2 or higher toxicities were prospectively collected during follow up after SABR, were graded based on Common Terminology Criteria for Adverse Events version 4.0, and were rated as unrelated, unlikely, possibly, probably, or definitely related to SABR. Toxicities rated at possibly, probably, or definitely related to SABR were analyzed in this study. The radiotherapy details are previously published in the protocol; because of previously published high grade toxicity in this setting, all cases underwent individual peer review and organs at risk were prioritized over the planning target volumes.

Results: The mean age was 68 years (SD 10.9, range 30-97). The participants were mostly male (69%). The most common histologies were prostate cancer (33%), colorectal cancer (14%), breast cancer (11%), and lung cancer (9%). The number of SABR treated sites were one (69%), two (22%), and three or more (9%). The most common sites of SABR were lung (33%), non-spine bone (28%), spine (14%), lymph nodes (13%), liver (5%) and adrenal (3%). Grade 2, 3, and 4 toxicity cumulative incidences were 11.4%, 4.6%, and 0.5%, respectively. There were no Grade 5 toxicities. Grade 2 or higher specific toxicity included 4.8% pain, 1.3% pneumonitis, and 0.8% neuropathy. There was no reported gastrointestinal fistula, perforation, or hemorrhage. Median follow-up, cumulative incidence and prevalence of toxicity at one, two, and three years will be presented once the toxicity committee has finished full review prior to the meeting.

Conclusions: The incidence of Grade 2+ SABR toxicity on this population-based study was 16.5%, which is lower than that reported on SABR-COMET (29%). Importantly, there were no Grade 5 toxicities attributed to SABR in this study to date. Severe (Grade 3 or higher) toxicities were uncommon (5.0%). These results are encouraging that, in a population-based program with rigorous peer review quality assurance, SABR treatment for oligometastases has acceptable rates of toxicity. This supports further enrollment in randomized Phase III trials.

3

TARGETING PPAR SIGNALING TO REVERSE LYMPHEDEMA SECONDARY TO CANCER TREATMENT

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Purpose: Lymphedema secondary to cancer treatment affects up to one in five cancer survivors. It is an irreversible late normal tissue toxicity characterized by swelling and scar formation (fibrosis) of the affected limb with physical and psychosocial health consequences for patients. Recent evidence reveals changes in peroxisome proliferator-activated receptor (PPAR) signaling as an underlying pathology of this disease. PPAR agonists have demonstrated therapeutic benefit in other fibrotic conditions; their role in lymphedema, however, remains unclear.

Materials and Methods: In this study, RNA-sequencing of human and murine tissues with and without lymphedema was performed. Samples included: human lymphedema (n=4), human control (n=5, matched for demographics and cancer history), murine lymphedema (n=12), and murine control (n=9). Pathway enrichment analysis was performed. An *in vitro* model of lymphedema fibrosis using cultured transforming growth factor beta (TGFB)-stimulated fibroblasts and an *in vivo* model of lymphedema using a murine surgical model of tail lymphedema were utilized to evaluate the effects of PPAR agonists on gene expression and fibrotic protein expression (pro-collagen Ia1, collagen) in lymphedema compared to controls.

Results: RNA-sequencing of tissue from human and murine lymphedema and control subjects identified that suppression of PPAR signaling was a hallmark of lymphedema fibrosis on pathway enrichment analysis (FDR <0.01). In the murine model, PPAR signaling gene expression changes co-occurred with fibrotic deposition beginning as early as two weeks after lymphedema development and continued for at least 35 weeks. Treatment of TGFB-stimulated fibroblasts with a PPAR agonist resulted in an increase in expression of PPAR genes and suppression of *COL1a1* gene expression (n≥9 per group, q<0.05) as well as reduction in the secretion of fibrotic proteins: pro-collagen Ia1 on ELISA (n≥8 per group, p<0.0001) and collagen I on Western blotting. PPAR agonist treatment of the murine model of lymphedema resulted in a significant reduction in lymphedema fibrosis as measured by trichrome collagen staining (n≥4 per group, p<0.05).

Conclusions: These data, for the first time, demonstrated the value of upregulating PPAR signaling to treat lymphedema. For this condition, which to date, has no cure, repurposing PPAR agonists for lymphedema treatment is a highly promising therapeutic opportunity, which warrants further investigation.

4

CHEMORADIATION WITH OR WITHOUT METFORMIN IN LOCALLY ADVANCED CERVICAL CANCER: PHASE II RANDOMIZED TRIAL

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Purpose: Tumour hypoxia is associated with poor response to radiation (RT) and chemotherapy, and worse treatment outcome. We previously discovered a novel mechanism of metformin in a xenograft model: enhancing tumour RT response by inhibiting tumour cell oxygen consumption. Our population-based study showed that cumulative dose of metformin after cervical cancer diagnosis was independently associated with a decreased risk of cervical cancer-specific mortality in diabetic women. Based on the pre-clinical and retrospective data, we hypothesized that metformin would decrease tumour hypoxia and improve tumour response to RT in locally advanced cervical cancer.

Materials and Methods: A window-of-opportunity, Phase II randomized trial was performed in women with Stage IB-IVA cervical adenocarcinoma, squamous cell or adenosquamous carcinoma. Patients underwent screening positron emission tomography (PET) imaging with hypoxia tracer fluoroazomycin arabinoside (FAZA). Those with non-hypoxic tumour (no FAZA uptake) were excluded. Patients with FAZA uptake were randomized centrally in a 2:1 ratio (in favour of metformin) to receive either metformin in combination with standard chemoRT or standard chemoRT alone. Metformin was started at 850mg once daily x 3 days, followed by 850mg twice daily throughout the entire duration of external radiotherapy. A second FAZA-PET/CT scan was performed after one week of metformin or no intervention in control group, just before start of chemoRT. The hypoxic volume was defined as all voxels within a tumour with standardized uptake values (SUVs) greater than three standard deviations (SD) from the mean gluteus maximus muscle SUV value. The hypoxic fraction (HF) was defined as the ratio of the number of hypoxic voxels to the total number of tumour voxels. The primary endpoint was *absolute mean change in HF* between the two FAZA-PET scans, compared using the Wilcoxon sign rank test. Disease-free survival (DFS) was defined as the duration of time from randomization to the time of relapse or death, and compared using the log-rank test. Target accrual was 48 patients; the study was closed early to accrual due to FAZA availability and the COVID-19 pandemic.

Results: Of the twenty patients who consented, six were excluded due to no FAZA uptake and one withdrew. The median age of the 13 enrolled patients was 52; eight (62%) had squamous cell carcinoma and eight had Stage IIB disease. HF of the 10 patients in the metformin arm decreased by an average of 10.2% (from 44.4 to 34.2%) ± SD 16.9% after one week of metformin, compared to an average increase of 4.7% (from 29.1 to 33.8%) ± 11.5% for the three patients in the control arm (p=0.027). With a median follow-up of 2.8 years, the two-year DFS was 67% for the metformin arm versus 33% for control (p=0.09).

Conclusions: Metformin decreases cervical tumour hypoxia with a trend towards improved DFS in this trial. A larger confirmatory trial is warranted.

5

BIOCHEMICAL FAILURE AND TOXICITY OF MAGNETIC RESONANCE IMAGING DOSE PAINTING TO DOMINANT INTRAPROSTATIC LESION IN PROSTATE HIGH DOSE RATE BRACHYTHERAPY

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Purpose: Multiparametric magnetic resonance imaging (mpMRI) is increasingly being used in high dose rate (HDR) brachytherapy treatment planning. Its enhanced soft tissue contrast over conventional computed tomography increases the ability to identify the dominant intraprostatic lesion (DIL) and enables focal boosting using HDR brachytherapy. This can have important implications for adjacent organs at risk. We therefore investigated the acute and late toxicities reported within our institutional experience with this approach.

Materials and Methods: We compiled four cohorts of prostate cancer patients treated with mpMRI dose painted HDR brachytherapy (either as a boost or as monotherapy on clinical trial) between December 2014 and October 2018. Salvage

brachytherapy was excluded. Three of the cohorts were from prospective clinical trials (MARS, HDR monotherapy and SPARE). For the MR-HDR boost cohort, pertinent demographic, clinical and dosimetric information were extracted from patients' medical records. Descriptive statistics were used to summarize baseline data. Toxicities experienced were coded using the Common Terminology Criteria for Adverse Events (CTCAE) version 3.0. The Nelson-Aalen estimator method using 95% confidence intervals was used to assess the cumulative incidence of biochemical failure (BCF; using the Phoenix Failure definition) and the cumulative incidences of Grade 2 or higher toxicity.

Results: One hundred forty-four patients with a mean age (65.6±6.7 years), follow-up (55.7±15.0 months) and baseline PSA (9.7±8.3 ng/mL), with predominantly cT2a (32.6%) and Gleason 7 (3+4; 62.0%) disease, were included in the final analysis. Fifteen patients treated with MR-HDR boost were followed elsewhere so no toxicity data were available at time of analysis. All risk groups were represented: low (10.4%), favourable (27.8%) and unfavourable intermediate (36.8%), and high (25.0%). Twenty-five of 137 (18%) experienced BCF with cumulative incidence rates of 20.6% at five years. A total of 41/129 (32%) patients experienced any Grade ³2 GU (one G3) and seven of 129 patients (5.4%) experienced any Grade ³2 GI (0 G3) toxicity. The cumulative incidence rates at five years was 33.2% for GU and 5.7% for GI, respectively. Neither BCF or toxicity (GU or GI) was significantly different between treatment groups.

Conclusions: Dose escalation to the DIL using mp-MRI dose painted HDR brachytherapy appears to be feasible, safe and well-tolerated. Further follow-up and investigation is warranted to determine whether MR-HDR improves outcomes compared to standard non MR-HDR brachytherapy.

6

ULTRA-HYPOFRACTIONATED (UHF) COMPARED TO MODERATE-HYPOFRACTIONATED (MHF) PROSTATE IGRT WITH HDR BRACHYTHERAPY BOOST(BB): FOUR-YEAR TOXICITIES AND LOCAL CONTROL

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Purpose: To analyze the long-term efficacy and safety of an UHF IGRT prostate treatment regimen with HDR BB.

Materials and Methods: In this single arm, prospective monocentric study, 28 patients with median age 69 years and D'Amico's intermediate risk prostate cancer (T1c, T2a-b), were recruited between the years 2015-2016 to an experimental treatment arm of 25Gy IGRT in 5 fractions with a 15Gy HDR BB. They were then compared to two control groups, treated with either 36Gy in 12 fractions or 37.5Gy in 15 fractions with a similar HDR BB. The control groups included 151 and 311 patients respectively.

Results: Patients' characteristics were similar between the three groups for age, Gleason score, stage and initial PSA. Patients outcomes were reported using the IPSS questionnaire at baseline and at each follow-up visit until 48 months. The three groups showed a significant decrease in average IPSS over time as compared to one-month post treatment. At 12 months, the average IPSS scores were 7, 9 and 9 and drop to 5, 7 and 7 at 48 months for the 25/5, 36/12 and 37, 5/5 regimens respectively. A greater reduction was seen in the experimental arm while being non-significant. The median treatment time to deliver IGRT was six days in the UHF group compared to 16 and 21 days in the control groups. Local control rates for each group were 100%, 95% and 91% respectively. No biochemical recurrence occurred in the UHF arm as defined by the Phoenix criterion. There was no significant difference in overall survival. Median follow-up for all groups combined was 55 months.

Conclusions: The UHF treatment scheme with HDR BB seems equivalent to standard treatment arms in terms of long-term toxicities and local control. The adoption of the UHF regimen would not only reduce the socioeconomic burden, it would offer the shortest treatment time for intermediate risk prostate cancer known to date, also of interest in the actual pandemic situation. Randomized control trials with larger cohorts are needed to further confirm our findings.

7

OCULAR BRACHYTHERAPY FOR INTRA-OCULAR MELANOMA: FIVE-YEAR LARGE COHORT OUTCOMES IN THE PROVINCE OF ALBERTA

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Purpose: Intra-ocular melanoma was historically treated with surgical enucleation, which conferred morbidity from vision loss, pain, cosmetic and social stigma. The use of ocular brachytherapy to treat intraocular melanoma was established by the COMS (Collaborative Ocular Melanoma Study) in 2004. Here we present the Alberta experience in treating intraocular melanoma with brachytherapy in a large cohort with approximately five years follow up.

Materials and Methods: Patients with localized intra-ocular melanoma were treated between 2011 and 2020. All patients had at minimum ocular ultrasound and CT staging. Treatment was done with temporary ocular brachytherapy at the Cross Cancer Institute with I-125 high-dose seeds (4.14 mCi average activity) mounted in COMS or Eye Physics-brand (Los Alamitos, CA) plaque. The planned treatment volume (PTV) was covered by 100% of the prescription dose of 70Gy and included 2mm beyond tumour base and extended to apex. Dose to critical structures was minimized through conformal techniques including variable loading, variable seed strength, and asymmetric placement. Kaplan Meier estimate curves were generated, and cox proportional hazard regression was utilized to evaluate statistical significant differences. We stratified for survival by Gene Expression Profiling (GEP) class and the tumour's Largest Base Diameter (LBD), measured time from treatment to recurrence/metastasis/death.

Results: Three hundred eighty-nine patients (average age 67) were treated with a median follow-up of 4.5 years. Median dose achieved was 70.3Gy. The main organs-at-risk (OARs) were optic disc and fovea, which received a median dose of 37.6Gy and 47.9Gy, respectively. There were 62 cases of disease failure by way of distant metastases, with no local failures. Three patients underwent post-brachy enucleations due to treatment toxicity. At five years, overall progression-free survival (PFS) was 86.6%, and overall survival was 87.3% (most deaths were not melanoma-related). Five-year PFS for GEP Class 1A/1B was 93.1% versus 75.3% for Class 2 (HR 4.5, $p<0.001$). Five-year PFS for patients with LBD <12mm was 97.7% versus 83.4% for LBD >=12mm (HR 7.7, $p=0.001$).

Conclusions: Ocular brachytherapy provides excellent local control and overall survival in treating intraocular uveal melanomas. Few serious post-RT toxicities were encountered requiring enucleation. LBD and GEP are strongly correlated with PFS. In Alberta, ocular brachytherapy continues to be a logistically feasible and effective organ-sparing approach to treating intra-ocular malignancy.

8

DOSIMETRIC PREDICTORS OF TOXICITY AND QUALITY OF LIFE FOLLOWING SINGLE FRACTION HIGH DOSE-RATE PROSTATE BRACHYTHERAPY

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Purpose: Little is known about optimal dose constraints when high dose rate (HDR) brachytherapy is used as monotherapy for prostate cancer. Most dose constraints for HDR monotherapy were extrapolated from predictors of toxicity when HDR brachytherapy was combined with external beam radiotherapy as a boost. We sought to determine clinical and dosimetric predictors of toxicity and health related quality of life (HRQOL) in men treated with HDR brachytherapy as monotherapy.

Materials and Methods: Eligible patients were treated with single fraction HDR brachytherapy as monotherapy on two prospective clinical trials at a single institution. Patients in the first trial (HDR-mono) received a single fraction of 19Gy without a dominant intraprostatic lesion (DIL) boost, and patients from the second trial (MARS) received 19Gy in a single fraction with an MRI-guided DIL boost to ≥23Gy. ADT was not used. Univariable and multivariable logistic regression was used to evaluate clinical (age, IPSS score, prostate volume, alpha blocker use at baseline, and receipt of a DIL boost) and dosimetric (prostate V100, V150, V200, D90, Urethral Dmax and D10, and Rectal Dmax and V80) predictors of CTCAE v4 acute/late toxicity and HRQOL changes measured with expanded prostate index composite (EPIC). Three classifications of late minimally clinically important changes (MCICs) were evaluated: small (>0.5 standard deviation [SD]), moderate (>1.0 SD) and severe (>2.0 SD) declines compared to baseline.

Results: One hundred forty-seven patients were included (87 from HDR-mono, 60 from MARS). Median follow-up was 62.8 months. Only increasing prostate size predicted acute GU toxicity ≥Grade 2 (OR 1.05, 95% CI 1.01-1.09, p=0.021). On multivariable regression, predictors of late GU toxicity ≥Grade 2 were not receiving a DIL boost (OR 3.78, 95% CI 1.88-7.83, p<0.001) and higher baseline IPSS score (OR 1.89, 95% CI 1.89-3.18, p=0.015). Rectal and urethral dose constraints were not associated with late GU/GI toxicity ≥Grade 2. Contrary to our hypothesis, small (OR 0.91, 95% CI 0.81-0.98, p=0.032) and moderate (OR 0.91, 95% CI 0.80-0.98, p=0.037) urinary MCICs were less frequent in those with higher urethral Dmax. No impact of urethra D10 on urinary MCICs was seen. Rectal Dmax and V80 did not predict bowel MCIC changes at any threshold.

Conclusions: We were unable to identify dose constraints that were predictive of late toxicity or relevant HRQOL changes in single fraction HDR brachytherapy. This suggests dose parameters used in these trials were safe, and that minor variability in plan dosimetry likely has little clinical significance. While increasing urethral Dmax paradoxically predicted for less frequent urinary MCICs, we do not believe this finding is clinically relevant. Further research exploring optimal dose constraints to be used in HDR brachytherapy as monotherapy for prostate cancer is warranted.

9

RESULTS OF PATIENTS TREATED WITH PROSTATE BRACHYTHERAPY FOR EARLY-ONSET (≤55 YEARS) PROSTATE CANCER

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Purpose: Decisions regarding the treatment modality in localized prostate cancer (PCa) is often based on treatment-related toxicity. There is very little contemporary data on outcomes and toxicity in early-onset (≤55 years) PCa. We analyzed the biochemical failure-free survival and erectile dysfunction (ED) In men ≤55 years treated with prostate seed brachytherapy (PB).

Materials and Methods: We questioned our prospectively maintained institutional database for patients ≤55 years treated with PB. erectile function at baseline and after treatment was assessed using the standardized physician-reported measure called the common terminology criteria for adverse event scale (CTCAE) Version 4.0. Biochemical failure (BF) was defined according to the phoenix consensus definition (PSA Nadir + 2 Ng/mL). The log-rank Test (Kaplan-Meier Method) and cox- regression analysis were used to calculate BF-free survival.

Results: Between July 2005 and November 2020, a total of 137 patients ≤55 years (range 44-55 years old) were treated. Median follow-up was 72 months. Twenty percent had Gleason 3+4 disease, 6% A PSA >10Ng/mL. Median prostate volume was 34cc. Actuarial biochemical recurrence-free survival at five, seven, and 10 years were 98%, 95% and 89%, respectively. On multivariate analysis, CAPRA-score (HR 4.46, 95%CI 1.76-11.33, p=0.002 and the dosimetric measure D90>130Gy (p=0.03) were predictive of BF. Five deaths occurred in our cohort, two due to cardiovascular cause, and three due to another cancer. All patients were able to have erections with or without medication at baseline. Of the patients with a baseline function of 0-1 (no or erectile dysfunction not needing medication), five years after PB, 80% of the 46 analyzed patients still had no or little ED. After seven years, the rate was 64% of 32 analyzed patients.

Conclusions: In early-onset patients treated with PB, recurrence rates are similar to patients who are older. Sexual function decreases with time, even in patients with good sexual function.

10

HIGH DOSE RATE BRACHYTHERAPY IN THE MANAGEMENT OF ANAL CANCER: A SYSTEMATIC REVIEW

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Purpose: Anal canal cancer is a rare malignancy that is primarily treated with combination of radiation and chemotherapy. Brachytherapy (BT) boost has been utilized to intensify dose to the primary tumour in hopes to improve efficacy. In this study, we aim to conduct a systematic review evaluating the impact of high dose rate (HDR) BT in the management of anal canal carcinoma on clinical outcomes and toxicities.

Materials and Methods: A systematic review of published articles was conducted using Medline, Embase, and The Cochrane Library databases using the following search terms: "anal", "anus", or "anal canal", "squamous", or "adenocarcinoma" and "cancer", "neoplasm", in combination with "brachytherapy", "high dose rate brachytherapy" or "HDR brachytherapy". Any additional studies identified in the references section of these articles were also screened for inclusion. Studies published in English and reporting outcomes of ³10 patients were included. Only the most recent experience was included if same patients were included in sequential publications.

Results: Ten cohort studies (eight retrospective and two prospective) that spanned three decades (1987-2018) involving

401 patients were included. All studies were mono-institutional. All patients were treated with curative intent external beam radiotherapy (EBRT) plus chemotherapy (CT) followed by BT. Three hundred ninety-two patients were treated with interstitial BT and nine received intraluminal BT. Six and five patients had undergone prior radical surgery or WLE, respectively. Average of median follow up among all studies was 39.9 months (range: 24-61 months). Range of complete response was between 80% and 93% in four studies and rate of local control ranged between 81% and 88% (three studies). Average rate of local failure (nine studies) was 12.3% (SD 3.6%, range: 8%-18%). Three studies reported rate of distant failure between 2% and 3% and other two reported metastases-free survival of 82% and 88%. Average five-year DFS and OS were 75.2% (SD 4.6%, range: 70%-82%) and 84.6% (SD 14.1%, range: 66%-100%). Acute toxicity was mostly Grade 1/2 dermatitis, proctitis or cystitis. Grade 3 or higher toxicity was noted only in four patients in two studies (dermatitis, n=3 and sphincter necrosis n=1). Most common long-term toxicity was anal incontinence (range: 2.5% - 9%) and proctitis (range: 2.5% - 19%). Average sphincter preservation rate and colostomy-free survival were determined to be 88.0% and 80.4%, respectively.

Conclusions: Brachytherapy can be an effective and safe tool in the management of anal cancer. Both retrospective and prospective studies have suggested improved outcomes with HDR in combination with EBRT and CT.

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THE CANADIAN ASSOCIATION OF RADIATION ONCOLOGY 2020 RADIATION ONCOLOGIST BURNOUT AND WORK ENGAGEMENT SURVEY

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Purpose: In 2018, the Canadian Medical Association acknowledged that physician health remains a significant threat to the viability of Canada's health care system. The prevalence of burnout among American oncologists was 44% in a 2014 survey. The purpose of this survey was to determine the national prevalence of burnout indicators and report work engagement among Canadian radiation oncologists.

Materials and Methods: Between November 2019 and March 2020 (pre-COVID-19 pandemic), an online questionnaire was distributed electronically to 333 Canadian radiation oncologists, across 49 centres, through the National Canadian Association of Radiation Oncology mailing list. The survey included 62 questions determining job engagement, and validated burnout scale The Maslach Burnout Inventory (MBI) (22 questions).

Results: Two-hundred forty-one of the 333 surveyed Canadian radiation oncologists (72%) completed the questionnaire and were included in this analysis. Responses to the MBI showed that 15% of radiation oncologists met the strict criteria for burnout (i.e. negative scores in all three domains: exhaustion, depersonalization, and low accomplishment). Another 60% scored negative in at least one of the three burnout domains. Using the more commonly reported definition of burnout (negative scores in either exhaustion and/or depersonalization), 44% of Canadian radiation oncologists reported burnout. Only 25% had positive scores in all three domains, and were fully engaged in their work. Three-domain burnout varied among jurisdictions with highest prevalence in British Columbia (22%) and lowest in Quebec (3%). The responses to work engagement questions revealed significant concerns regarding inefficiency in workflow (50%), heavy workloads (>50%), poor work-life balance (68%), lack of control over the work environment (47%) and lack of recognition from administrators (45%). Forty-eight percent perceive the atmosphere at their primary work area as "chaotic and hectic". Within the last three years, 41% had considered leaving their institution to work elsewhere and 51% were considering reducing their full-time equivalent (FTE). Reassuringly, 80% reported a sense of overall ability to provide high quality care and a 59% feel they have a supportive network of colleagues and 80% are willing to try something new. The top four strategies identified by respondents aimed to improve work-life quality were: (1) more support staff at work; (2) more efficient care models; (3) more resources for patients; and (4) lighter workloads for physicians.

Conclusions: Our survey showed that only 25% of Canadian radiation oncologists are fully engaged in their work, whereas 15% met the strict criteria for burnout and 44% met the commonly used burnout criteria. With the rising incidence of cancer and complexity of care, there is an urgent need for system change, leverage enthusiasm to "try something new", and develop appropriate strategies to improve the well-being of the Canadian radiation oncologist workforce.

12

IS REMOTE LEARNING AS EFFECTIVE AS IN-PERSON LEARNING FOR CONTOURING EDUCATION? A COMPARISON OF FACE-TO-FACE VERSUS ONLINE DELIVERY OF THE ANATOMY AND RADIOLOGY CONTOURING BOOTCAMP

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Purpose: The Anatomy and Radiology Contouring (ARC) Bootcamp was a three-day in-person intervention providing integrated radiology, anatomy, and contouring education for radiation oncology (RO) residents and medical physicists. The course consisted of didactic radiology and contouring lectures, small group anatomy sessions using cadaveric prosections, and real-time contouring using commercial software. Acknowledging the importance of increasing access to the Bootcamp, we launched an online version of the ARC Bootcamp in November 2019. We evaluated the online (ONL) course's impact on participants' knowledge acquisition, contouring skills, and self-confidence by comparing it to the face-to-face (F2F) course.

Materials and Methods: The F2F Bootcamp was adapted into an ONL version using the Teachable platform (teachable.com). The ONL course was structured in a linear progression of locked modules to offer similar content to the F2F comparator. Participants from the 2019 F2F and the 2019–2020 ONL Bootcamp provided consent for the study and completed pre-and post-intervention evaluations, which assessed anatomy/radiology knowledge, contouring skills, anatomy/radiology knowledge and contouring self-confidence, and course satisfaction.

Results: Fifty-seven (F2F: n=30; ONL: n=27) participants completed both evaluations. The ONL course had a substantially wider geographic participation, with participants from 19 countries (versus four countries in the F2F course) completing the pre-evaluation. F2F had primarily RO resident participation (80%)

compared to ONL (41%). In the ONL course, most were from a different field (52%), including medical physics residents or medical students. Compared to baseline self-assessments, both cohorts demonstrated similar self-confidence improvements with their anatomy/radiology knowledge, contouring skills, and in interpreting radiology p<0.001). In the anatomy/radiology knowledge testing, the ONL group showed improvement (mean improvement ± SD: 4.6 ± 6.3 on a 40-point scale; p<0.001) but the F2F group did not (1.6 ± 5.6; p=0.159). The F2F group demonstrated improvement with the contouring assessment (mean ± SD: 0.10 ± 0.17 on a 1-point Dice scale; p=0.004), whereas only a trend was found for the ONL group (0.07 ± 0.16; p=0.076). Both cohorts perceived the course as a positive learning experience (F2F: 4.8 ± 0.4 on a 5-point scale; ONL: 4.5 ± 0.6) and stated it will improve their professional practice (F2F: 4.6 ± 0.5 on a 5-point scale; ONL: 4.2 ± 0.8). Both groups would recommend the course to others (F2F: 4.8 ± 0.4 on a 5-point scale; ONL: 4.4 ± 0.6).

Conclusions: The ONL ARC Bootcamp achieved similar results as the F2F version, with improved self-confidence, knowledge scores, and high satisfaction levels among participants. The ONL course is more accessible to diverse geographic regions and disciplines, allows for ongoing education during the COVID-19 pandemic, and can be used as a framework to develop other online educational interventions in radiation oncology.

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BURNOUT AND RESILIENCY ASSESSMENT OF CANADIAN RADIATION ONCOLOGY TRAINEES DURING THE EARLY PHASE OF THE COVID-19 PANDEMIC

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Purpose: The objective of this study is to assess the impact of the COVID-19 pandemic on Canadian Radiation Oncology trainees' clinical duties, education, and perceptions of burnout, as well as explore their resources and resiliency strategies.

Materials and Methods: We distributed a cross-sectional, anonymous survey to Radiation Oncology trainees at all 13 Canadian training programs between April and June 2020. Demographic, clinical duties, education, sleep, resiliency activities, and wellness resources information were collected. Burnout was measured using the validated Oldenburg Burnout Inventory (OLBI). Linear regression was used to assess independent associations between variables and burnout scores. Both univariate and multivariable analyses were performed with two-sided p<0.05 considered significant.

Results: Seventy completed surveys from 62 residents and eight fellows were received for a response rate of 41% based on 172 trainees in Canada. Respondents were 60% male, 80% between ages 25-34, and encompassed all PGY levels and training programs. The COVID-19 pandemic resulted in reduced clinical duties, including fewer in-person clinics (83% of respondents) and less treatment planning activities (37%). There were more virtual clinics (71%) but total clinic volume was reduced (50%). Learning opportunities decreased with fewer academic day lectures (51%), less in-clinic staff teaching (70%), and fewer education-related rounds (84%). A total of 41% missed work or worked from home due to self-isolation, and 7% were redeployed to COVID-related care services. The average OLBI score was 2.39 (standard deviation 0.49) with sub-scores of 2.47 (SD 0.51) for exhaustion (EX) and 2.35 (SD 0.45) for disengagement (DE). Thresholds meeting criteria for burnout (EX ≥2.25; DE ≥2.1) were exceeded in 52 (74%) and 53 (75%) respondents, respectively. Twenty-eight respondents (40%) self-reported more burnout symptoms compared to pre-pandemic. On multivariable analysis, female gender was associated with higher OLBI and DE scores; fair/poor sleep quality with higher EX scores; fewer social interactions and decreased self-learning with higher OLBI, DE, and EX scores. Only 11 respondents (16%) accessed wellness or support resources, mostly virtual counseling and peer support. The highest ranked resources for promoting wellness and resiliency during the pandemic were family/childcare resources, private counseling, and mental health support programs. The lowest ranked resources were diet/nutrition, personal/time management coaching, and mindfulness sessions/meditation.

Conclusions: Our study indicates the prevalence of burnout was high among Radiation Oncology trainees during the early stages of the COVID-19 pandemic. Residency programs are encouraged to support trainees by adapting learning needs and formats, develop appropriate strategies to improve trainee well-being, and include physician wellness education and resiliency training in the core curriculum.

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LEARNING IN 360 DEGREES: THE USE OF VIRTUAL REALITY FOR RADIATION THERAPY PATIENT EDUCATION

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Purpose: External beam radiation therapy (EBRT) is not well understood by the cancer patient population and this lack of understanding can increase anxiety around the procedure. Conventional written or verbal education may not provide patients with a clear picture of the complex technical aspects of EBRT treatment. Commercially available technologies such as Virtual Reality (VR) can immerse an individual in a 360 degree virtual world and are increasingly being used to manage anxiety through exposure and education in various medical settings. The purpose of this study was to determine if the integration of a VR video depicting EBRT from the patient's point of view into conventional patient education decreases patient anxiety prior to treatment.

Materials and Methods: The study population included patients having EBRT to the pelvis in the supine position. Eligible participants had to be able to see and hear using VR goggles and provide written informed consent. Patients with a confirmed diagnosis of vertigo or a prior history of EBRT were excluded. Participants were randomly assigned to either the control or the intervention arm. Before their first EBRT treatment, all participants completed the National Comprehensive Cancer Network's Distress Thermometer (DT) as a pre-intervention assessment of anxiety. Participants in the control arm then received only the standard patient education while participants in the intervention arm received the standard education and watched the VR video. All participants then completed a post-intervention DT and a modified Cancer Treatment Survey (CaTS) to assess participant satisfaction with the education received. Descriptive statistics were calculated for all variables of interest. The primary endpoint of pre-post anxiety between groups was assessed using a two-tailed paired t-test.

Results: All participants were accrued from a single academic cancer centre in a large metropolitan area. In total, 56 patients were approached, 40 consented to participate and three withdrew. From the remaining 37 participants, 19 were assigned to the control arm and 18 to the intervention arm.
Participants were accrued from the genitourinary, gastrointestinal and gynaecological site groups. Overall, 26 participants were male and 11 were female, with both groups evenly distributed between the study arms (X2=1.15, p=0.28). Pre-intervention anxiety levels recorded on the DT scale from 0 (no distress) to 10 (extreme distress) were generally low for all participants in both the control arm (X=2.41, SD=2.33) and the intervention arm (X=2.31, SD=2.25).

The difference between pre- and post-intervention anxiety was not significant in the control arm (X=2.05, SD=2.21, p=0.77) but was found to be significantly different in the intervention arm with post-intervention anxiety being significantly lower (X=1.32, SD=1.38, p=0.02). Responses to the Likert scale questions on the CaTS showed similar levels of satisfaction with the education received.

Conclusions: Participants in the intervention arm reported significantly less anxiety following the VR video while participants in the control arm displayed the same level of anxiety at both time points. This introductory look at the use of VR for radiation therapy patients suggests that VR could be a valuable tool for patients dealing with treatment related anxiety. We are currently exploring whether viewing the VR video earlier in the care pathway will further decrease anxiety in this patient population.

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PREPARING FOR BEREAVEMENT: A QUALITATIVE EXPLORATION OF INFORMATION AND SUPPORT FOR PRIMARY CAREGIVERS OF PATIENTS WITH TERMINAL CANCER UNDERGOING PALLIATIVE RADIATION THERAPY

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Purpose: Whereas much is known about the needs and preferences of patients undergoing palliative radiotherapy, only scant reports describe the experiences of the caregivers for these patients. Given that approximately 50% of radiation therapy prescriptions are delivered with palliative intent, research into the caregiver experience is important. The aims of this study were to define the information and support needs for these caregivers during and after palliative radiotherapy, determine the effectiveness of the existing supports and information provided to them, and to explore their bereavement experiences.

Materials and Methods: A phenomenology method was chosen for this project. Participants participated in a telephone interview using semi-structured interview questions. The interviews were scheduled six to eight weeks after the death of the patient. The interviews were recorded and transcribed. The data collected was analyzed using grounded-theory. Transcript data was coded using an iterative process with the aid of Quirkos qualitative analysis computer software.

Results: A total of nine caregivers participated in a telephone interview out of ten who consented between July 2019 and October 2019. Three caregivers interviewed were male and six were female with a mean age of 60.7 years (range 49-75). The relationship of the carers to the deceased consisted of: one husband, one ex-wife and two wives, two daughters, two sons. All patients had a Stage IV cancer: lung (n=4), melanoma (n=2), primary unknown (n=1), prostate/bladder (n=1), breast (n=1). The patients in this study died at home (three), hospice (two), hospital (two) and retirement home (two). One patient died by medical assistance in dying. The main themes identified were: patient and caregiver preparedness for diagnosis; prior death experiences; support during caregiving (equipment, informational and emotional); caregiving challenges (communication/Information, delays in care); preparedness for death (end of life events, caregiving strain); post-death (paperwork, reflections of death, positive experiences, being remembered).

Conclusions: This study was successful in exploring each of the nine caregivers' cancer journey, and identifying and evaluating the information and supports that were provided to them during palliative radiation therapy. Carers want clear communication from health-care professionals. They appreciate early information on prognosis, medical assistance in dying and advance care planning. Carers want information that describes their own financial responsibilities and prefer information on government benefits being introduced early on as they plan for bereavement.

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REQUISITE KNOWLEDGE AND SKILLS FOR THE INTEGRATION OF MRI IN RADIATION THERAPY PRACTICE: AN INTERNATIONAL MODIFIED DELPHI STUDY

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Purpose: To obtain consensus from international experts on the requisite knowledge and skills for Radiation Therapists (RTTs) to use and operate magnetic resonance imaging (MRI) in Radiation Therapy (RT) practice.

Materials and Methods: A two-round modified Delphi process was used to obtain expert consensus. The compliment of expertise in all rounds included international representation from RTTs, RTTs dual certified in MRI (RT(T/MR), MRI technologists (RTMR), medical physicists and radiation oncologists. In Round 1, a preliminary list of potential knowledge and skills statements was generated through a review of public and professional resources, published materials and semi-structured one-on-one interviews with experts. In the Round 1 e-survey, each statement was scored independently on a 9-point Likert scale (1 = strongly disagree, 9 = strongly agree) indicating the appropriateness for inclusion in an MRI in RT competency profile, on a 3-point Likert scale for clarity, and lastly experts could provide commentary and recommend additions. Thematic analysis of experts' comments and recommendations was then performed. In the Round 3a e-survey, experts scored statements that were significantly reworded and new statements that were generated based on the Round 2 thematic analysis on the same 9-point Likert scale. Statement means and standard deviations were calculated using the responses. Statement means were order ranked and quartiles were calculated to assess the spread of agreement on items within a domain. Statements in the lowest quartile were dropped after Round 2a, while statements in the highest quartile were included in the final inventory of requisite knowledge and skills. Statements in the intermediate quartile were rescored using a binary system in the Round 2b e-survey, with only the statements ranked for inclusion by ≥75% of experts being included in the final inventory.

Results: An initial 70 knowledge and skills statements were compiled from published literature; MRI course syllabi, including recommended textbooks; competency profiles for RTT and RTMR; and a total of 30 interviews to achieve thematic saturation. The statements were organized into four overarching domains: 1) MRI Image Formation and Interpretation which was subdivided into MRI Theory, Cross-Sectional Anatomy and Physiology, and Physics and Instrumentation; 2) Patient Care and Safety, 3) Quality Assurance and Quality Control; and 4) Practical Integration and Application of MRI. Of the 56 international experts invited to participate in Round 2, 22 (39%) participated. Round 2 responses resulted in the language of four statements being significantly reworded, two new statements being generated, and two statements being excluded. The scoring in Round 3a by 14 experts resulted in 34 statements included, 19 statements excluded and 17 statements indeterminate. In Round 3b, the same 14 experts rescored all indeterminate statements resulting in 14 statements ranked for inclusion. The final inventory of knowledge and skills includes 48 statements organized into the four domains.

Conclusions: The final inventory of MRI in RT knowledge and skills may inform a competency profile and the development of education and training opportunities to ensure safe practice and successful implementation of MRI in RT departments.

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ASSESSMENT OF SALVAGE RADIATION THERAPY VOLUME BASED ON 18F-DCFPYL PSMA PET/CT IN PATIENTS WITH BIOCHEMICAL RECURRENCE AFTER RADICAL PROSTATECTOMY

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Purpose: Studies have demonstrated that 68Ga PSMA-PET/CT scan may be useful in delineating appropriate radiation volume in the salvage setting. However, 18F-DCFPyL tracer PET/CT scan in salvage radiation RT contour has not been studied extensively. The purpose of the study is to investigate the potential impact of 18F-DCFPyL PSMA in the planning process and in delineation of salvage RT volume in patients with biochemical recurrence after RP.

Materials and Methods: From March 2017 to January 2020, patients with biochemical failure or equivocal findings on the conventional imagines after RP were eligible to enroll in a clinical trial (NCT02899312) based on discretion by a radiation oncologist or a urologist. Using the CT portion of the PSMA scan, post-op prostate volumes were contoured based on Radiation Therapy Oncology Group (RTOG) consensus guideline to assess the coverage of standard radiation field. Each patient was stratified by the following based on the contour coverage: 1) no visible recurrent disease; 2) recurrent disease within prostate bed contour; 3) recurrent disease outside of prostate bed contour but within pelvic contour; and 4) recurrent disease outside of the combined contours.

Results: Ninety-six patients were identified and included in the study. Median age was 70 years at the time of PSMA. Seventy-four patients were referred for biochemical failure, 12 were referred for equivocal finding, and 10 were referred for both indications. The rest of the results are pending.

Conclusions: 18F-DCFPyL tracer PET/CT tracer has longer half-life and lower positron energy, which may result in superior spatial resolution and convenience compared to the 68Ga PSMA-PET/CT scans. It is not clear if these features would have any clinical impact in comparison to the literature featuring 68Ga PSMA, and the results of this study may provide preliminary data in the setting of salvage radiation contouring.

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PSMA-PET-BASED RESPONSE ASSESSMENT OF METASTATIC PROSTATE CANCER RESPONSE TO RADIOTHERAPY: A CASE SERIES

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Purpose: 18F-DCFPyL-PSMA positron emission tomography (PSMA-PET) is a powerful imaging modality with proven role in modifying prostate cancer staging and management. Here, we discuss early evidence indicating that PSMA-PET may also be a useful tool for assessment of tumour response to local treatment. We present a case series of oligo-metastatic prostate cancer patients, who received radiotherapy to metastatic sites based on conventional imaging and were subsequently re-staged with PSMA-PET upon biochemical progression.

Materials and Methods: Four men with metastatic prostate cancer, whose metastases were detected on CT and/or bone scan are presented. A total of seven metastatic lesions received palliative hypo-fractionated, stereotactic body radiotherapy (SBRT) or stereotactic radio-surgery (SRS) treatments (16-35Gy in 1-10 fractions) using linear accelerators or Cyberknife units. Upon PSA progression, patients were re-staged with PSMA PET to assess oligo-progression versus poly-metastasis.

Results: All treated patients initially showed substantial biochemical (PSA) control for at least six months after radiotherapy before demonstrating progression. PSMA-PET scans were completed two to six years after the last course of radiotherapy. Almost all treated metastatic sites maintained complete PSMA-PET-based response to radiotherapy, except a spinal metastasis that received SRS of 16Gy. The radio-tracer-based response was impressive even in lesions treated with standard palliative courses of radiotherapy of 20Gy in 5 fractions.

Conclusions: These cases demonstrate interesting observations on the sensitivity of metastatic prostate cancer to radiotherapy, as well as the validity of PSMA PET as a definitive disease response assessment. Beyond performing well as a staging imaging modality that alters prostate cancer management, PSMA-PET imaging introduces a novel non-invasive avenue for assessment of prostate cancer response to therapy. Early clinical evidence suggests that PSMA PET imaging could become an effective clinical tool to improve our understanding of the biology of metastatic prostate cancer and its sensitivity to radiotherapy. Formal studies are required to assess the exact role and benefit of PSMA PET imaging in this setting.

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DEVELOPMENT OF WEB-BASED QUALITY-ASSURANCE TOOL FOR RADIOTHERAPY TARGET DELINEATION FOR HEAD AND NECK CANCER: QUALITY EVALUATION OF NASOPHARYNGEAL CARCINOMA

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Purpose: We developed QUANNOTATE, a new web-application for rapid review of radiotherapy (RT) target volumes, and used it to evaluate the relationship between target delineation compliance with the international guidelines and treatment outcomes in nasopharyngeal carcinoma (NPC) patients undergoing definitive RT.

Materials and Methods: The dataset used for this study consists of anonymized CT simulation scans, RT structures, and clinical data of 332 pathologically confirmed NPC patients treated with intensity-modulated RT between July 2005 and August 2017. We imported the contours of intermediate risk clinical target volumes of the primary tumour (IR-CTVp) receiving 56Gy into QUANNOTATE. We determined inclusion of anatomic sites within IR-CTVp in accordance with 2018 International guideline for CTV delineation for NPC and correlated the results with time to local failure (TTLF) using Cox-regression.

Results: At a median follow-up of 5.6 years, five-year TTLF and overall survival rates were 93.1% and 85.9% respectively. The most frequently non-guideline compliant anatomic sites were sphenoid sinus (n=69, 20.8%), followed by cavernous sinus (n=38, 19.3%), left and right petrous apices (n=37 and 32, 11.1% and 9.6%), clivus (n=14, 4.2%), and right and left foramen rotundum (n=14 and 12, 4.2% and 3.6%). Among 23 patients with a local failure (6.9%), the number of non-compliant cases were eight for sphenoid sinus, seven cavernous sinus, four left and three right petrous apices, and two clivus. Compared to conforming cases,

cases which did not contour the cavernous sinus had a higher local failure (LF) rate (89.1% versus 93.6%, p=0.013). Multivariable analysis confirmed that lack of cavernous sinus contouring was prognostic for LF.

Conclusions: QUANNOTATE allowed rapid review of target volumes in a large patient cohort. Despite an overall high compliance with the international guidelines, under coverage of the cavernous sinus was correlated with LF.

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MACHINE LEARNING CLASSIFIER TO REPRODUCE LUNG METASTASES TUMOUR BOARD DECISIONS

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Purpose: Multidisciplinary tumour boards (MDTs) are an opportunity for specialists to meet and discuss the diagnosis and management of cancer patients. In our institution, patients with lung metastases are reviewed at a specialized tumour board comprising radiation oncologists, medical oncologists, surgeons, and radiologists. During these meetings, treatment recommendations for patients are made after a careful review of the patients' clinical history and relevant investigations. The objective of this study is to develop a machine learning classifier that reproduces MDT decision making and can be used as a decision support system to facilitate quality assurance and knowledge sharing in future MDTs.

Materials and Methods: Treatment decisions were manually gathered from patients discussed by the lung metastases MDT from 2016 to 2020 through clinical notes in the electronic medical records. Twenty-two variables were collected, including: age, gender, primary cancer histology, the number of lesions, the size of lesions, the presence of mediastinal/hilar lymphatic spread, the number of lobes/anatomical regions involved, disease free interval, ECOG status, and the presence of extra thoracic metastases. The target variable was binary: local therapy (SBRT or surgery) versus non-local therapy (systemic therapy, surveillance and palliative radiation). The dataset was split into a training, validation, and test set using a 60/20/20 split. Multiple machine learning models were evaluated (logistic regression, decision tree, support vector machine, naïve Bayes, random forest) with a combination of feature engineering, feature selection, and hyper parameter tuning.

Results: The dataset contains treatment decisions for 506 patients. The ages of patients ranged from 17 to 92 years old, with 215 female and 291 male patients. The most common primary cancers included colorectal (105), sarcoma (102), and head and neck (80). The dataset consisted of 235 local therapy, 111 systemic therapy, 152 surveillance, and eight palliative radiation decisions. The best performing model was a random forest classifier, which classified local therapy versus non-local therapy decisions with an AUC of 86.6% and accuracy of 80.2%. The two most predictive features were the number of lesions and number of lobes/anatomical regions involved with metastases.

Conclusions: This study demonstrates that relatively simple variables taken from patient records can be used to create a model that generates recommendations concordant with an MDT. The next steps of the study include extracting and processing cross-sectional imaging to acquire exact tumour dimensions, density and location with respect to the pleura, fissures, bronchi, and vessels. This may improve the current classifier performance, as well as allow for more detailed predictions such as further classifying local treatment decisions into surgery and SBRT.

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RESPONSE AND TOXICITY PATTERNS SEEN IN PATIENTS TREATED WITH COMBINATION IMMUNOTHERAPY AND RADIOTHERAPY IN THE UNSCARRED (UNRESECTABLE SQUAMOUS CELL CARCINOMA TREATED WITH AVELUMAB AND RADICAL RADIOTHERAPY) STUDY

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Purpose: Combination immunotherapy (IO) with radiotherapy (RT) is theorized to have additive/synergistic effect in treating cancers. PD-1/PD-L1 blockade and RT have both shown very good response rates in cutaneous squamous cell carcinoma (cuSCC) independently. Combination of RT and IO is currently understudy in the UNSCARRed trial. The response/toxicities to RT and IO can be unpredictable, and thus we review here the patterns of response and toxicities seen to date in trial patients.

Materials and Methods: Patients with non-metastatic unresectable cuSCC were enrolled in UNSCARRed (NCT#:03737721), a single arm study delivering five q2week cycles of Avelumab (PD-L1 inhibitor) with 60-66Gy / 30-33# RT starting with cycle 2. The patterns of cuSCC response and toxicities experienced by these patients were reviewed as per clinical / imaging studies, pathologic analysis and CTCAE 5.0 criteria, respectively. Biomarker testing including PD-L1 staining is a secondary objective of the trial.

Results: Seven out of 20 patients have completed the experimental treatment. Median age was 80, and common sites of disease was scalp and head and neck. All except one patient completed the per-protocol treatment, with one patient omitting the last IO cycle due to chest pain. Common toxicities include Grade 1-2 dermatitis (all), Grade 1 fatigue (three), Grade 1 dry mouth (two), and Grade 2 cutaneous infections (three). One patient had Grade 3 bleeding from tumour site, one had Grade 2 hepatitis. All toxicities resolved in follow-up. Six out of seven patients experienced an objective response. One patient had progression on treatment with early discontinuation and one experienced biopsy-confirmed pseudo progression on treatment, but then went on the have a complete response.

Conclusions: Patterns of response for RT+IO can be complex compared to RT alone with a potential for progression, pseudo progression or partial/complete response. Toxicities are limited and easily treated, with patients in this advanced age cohort showing combination of RT+IO appeared feasible with good response.

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ARTIFICIAL INTELLIGENCE FOR CLINICAL DECISION-MAKING SUPPORT IN RADIATION THERAPY FOR CNS TUMOURS

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Purpose: To use a machine learning (ML) model to create and investigate a novel, decision-support application by training this model to classify previously delivered radiotherapy (RT) plans into: plans that met PTV planning objectives and plans for which PTV objectives were not met due to the priority given to one or more OARs (i.e. a trade-off was required). Once trained, the ML algorithm would be able to predict which new plans would require a trade-off (or not).

Materials and Methods: The model was developed based on 79 RT plans that were prescribed a total dose of 60Gy delivered in 30 fractions using VMAT. Data for model training were extracted from RT plans and consisted of five dosimetric features (PTV D99%, optic chiasm D1%, cochleae DMAX, and brainstem DMAX) and five geometric features (PTV volume and minimum distance Δd

from PTV to brainstem, optic chiasm and cochleae). Model output was represented by the binary categorical variables with 54 plans belongs to class-0 (PTV objective was met) and 25 plans belong to class-1 (PTV objective was not met due to the priority trade-off to meet one or more OAR constraints). One model was selected for further investigation amongst those evaluated: Support Vector Machine, Elastic Net, Logistic Regression, and Random Forest using double-nested cross-validation and AUC-ROC metric. The selected model was then evaluated on the test data (20% of all the data). The model predictions were explained with Shapely additive explanation (SHAP) interaction values.

Results: The AUC score was 0.9994 (±0.0012) for Logistic Regression, 0.9979 (±0.0025) for Random Forest Classifier, 0.9986 (±0.0028) for Elastic Net, and 0.9726 (±0.0059) for Support Vector Machine. The highest-performing model was Logistic Regression achieving an accuracy of 93.8±4.1% and AUC of 0.98±0.02 on the testing data. The SHAP analysis indicated that the deviation from the D99% (ΔD99%) for PTV had the greatest influence on the model predictions and was approximately 3.5 times more important than the second most important feature – ΔD1% for optic chiasm. The third and fourth most important features were Δd from PTV to brainstem and optic chiasm respectively. The least important features were ΔDMAX for cochleae. Also, larger Δd between PTV and OARs as well as less ΔD99% for PTV were associated with less contribution to model prediction. Other dosimetric features showed linear and positively correlated relationships to their contribution in model prediction.

Conclusions: The trained model achieved satisfactory accuracy and can be used by medical physicists in a data-driven quality assurance program as well as by radiation oncologists to support their decision-making process in terms of which plan would need special attention for potential plan modifications. Model explanation analysis showed that the model relies on clinically valid logic when making predictions.

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COST-EFFECTIVENESS OF SABR IN OLIGOMETASTATIC CANCER: AN ECONOMIC ANALYSIS BASED ON LONG-TERM RESULTS OF THE SABR-COMET RANDOMIZED TRIAL

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Purpose: Our published economic analysis of the SABR-COMET randomized trial determined that SABR is cost-effective for patients with one to five oligometastases, with incremental cost-effectiveness ratios (ICERs) of $37,157 (2018 CAD$) and $54,564 (2018 USD$) for the Canadian and American healthcare systems, respectively. Long-term outcomes from SABR-COMET, with a median follow-up of 51 months, are now available. The aim of this study is to re-evaluate the cost-utility of SABR for oligometastatic cancers in the context of these new results.

Materials and Methods: The published Markov model was updated to perform a cost-utility analysis based on the long-term results of the SABR-COMET trial from the Canadian and American payer perspectives. Utility values and probabilities were derived from individual patient-level trial data. Costs were extracted from the published literature and adjusted to 2018 Canadian dollars and 2018 US dollars. Deterministic sensitivity analyses were performed to obtain thresholds at which each strategy would be preferred. Probabilistic sensitivity analysis was performed to assess the robustness of this model. A lifetime horizon was used with a cycle length of three months. A willingness-to-pay threshold of $100,000 in each respective currency, per quality-adjusted life year (QALY) was used. QALYs and costs were discounted at a rate of 1.5% and 3% for Canadian and American analyses, respectively.

Results: In the base case scenario, SABR was cost-effective at an ICER of $30,793 (CAD) and $48,370 (USD) per QALY gained. This finding was most sensitive to the difference in systemic therapy use (ICER: $25,051-48,021[CAD]; $36,319-69,096 [USD]), number of metastatic lesions treated with SABR (ICER: $22,702-44,709 [CAD]; $40,868-70,874 [USD]), and variation in general cancer care cost (ICER: $24,780-36,807 [CAD]; $38,377-58,362 [USD]). Probabilistic sensitivity analysis revealed that SABR was a cost-effective strategy in 99.9% of tested iterations.

Conclusions: This updated decision-analytic model suggests that SABR for patients with one to five metastatic lesions is more cost-effective than was initially estimated in both Canadian and the American health care systems. As systemic therapies for metastatic cancer are rapidly evolving, the efficacy and value of SABR with novel agents are currently undergoing further prospective evaluation.

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POPULATION-BASED ANALYSIS OF OUTCOMES FOR PATIENTS WITH BRAIN METASTASES FROM EPIDERMAL GROWTH FACTOR RECEPTOR MUTATION POSITIVE NON-SMALL CELL LUNG CANCER TREATED WITH TYROSINE KINASE INHIBITOR ALONE OR COMBINED WITH RADIOTHERAPY

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Purpose: With modern therapies, the median survival of patients with brain metastases (BrM) from non-small cell lung cancer (NSCLC) with epidermal growth factor receptor mutation (EGFRm) may exceed one to two years. BrM directed therapies must therefore carefully balance treatment efficacy and late toxicity. Although some tyrosine kinase inhibitors (TKI) exhibit intracranial activity, there is no level-one evidence to support up-front treatment of BrM using TKI without radiotherapy (RT). This study aimed to compare the outcomes of patients with BrM from EGFRm NSCLC treated with initial RT and TKI, versus TKI alone.

Materials and Methods: All patients who received a TKI (gefitinib, erlotinib, afatinib, or osimertinib) in British Columbia for NSCLC between January 2010 to 2018 were identified in a provincial pharmacy database. Patients were then screened for pathologic diagnosis of EGFRm, and radiologic diagnosis of BrM. These patients were categorized as receiving either TKI alone or RT with TKI for treatment of their BrM. Patients who received RT were cross-referenced with a provincial RT database to determine radiotherapy prescriptions and were classified as having received whole brain (WBRT) with TKI or stereotactic RT/radiosurgery (SRS) with TKI. Patients were excluded if they discontinued TKI after RT or ever received surgery for BrM. Overall survival (OS)

and intracranial progression free survival (iPFS) were calculated from the date of BrM diagnosis using Kaplan-Meier analysis. Log rank test was used for comparison between groups, and Cox proportional hazards model was used for multivariate analysis.

Results: A total of 167 patients were included for analysis with a median follow up of 45 months. Median OS was 19 months with WBRT (n=76), 21 months with SRS (n=45), and 6 months with TKI alone (n= 46), p<0.01. In patients who had WBRT, iPFS was better than in those having TKI alone [HR 4.68 (2.07-10.56); p<0.01] or SRS [HR 2.43 (1.20-4.91); p<0.01]. On multivariate analysis: advanced age, worse performance status, presence of extracranial metastasis, greater than 10 BrM, and type of treatment (TKI alone versus RT with TKI) were associated with inferior OS.

Conclusions: This study showed that compared to treatment with TKI alone, the addition of RT for BrM is associated with an improved OS in patients with EGFRm NSCLC. These results are complementary to the growing body of retrospective data suggesting an inferior survival associated with TKI alone compared to RT with TKI for treatment of BrM in patients with EGFRm NSCLC. Prospective studies are required to further guide the best approach to managing this patient population.

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EXTREME WEEKLY LOCO-REGIONAL HYPOFRACTIONATED RADIATION IN ELDERLY WOMEN WITH NON-METASTATIC BREAST CANCER

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Purpose: Breast cancer loco-regional (LR) radiation in the elderly requires careful consideration between the benefits of aggressive treatment and its potential toll on elderly patients. Extreme weekly LR hypofractionated radiation (HFRT), defined as a fractionation regimen delivering more than 5Gy per fraction, given weekly, is a treatment option that may be better suited in such a population. It represents a good compromise between omitting and exhaustive daily radiation over several weeks, especially in frail and elderly women. This study aims to report the local and LR control rate as well as the acute and long-term side effects of the elderly patients treated with HFRT in our institution, and to compare these results to those from the literature.

Materials and Methods: We conducted a retrospective study by reviewing medical records of elderly patients with breast cancer treated with adjuvant once-weekly LR HFRT between 2011 and 2020. Fifty patients presenting with primary non-metastatic breast tumours (Stage I–III) were included. Treatment outcomes including local/LR control, distant metastasis, cause-specific survival, and overall survival were reported. Early and late toxicity profiles were also assessed.

Results: After a median follow-up of 4.8 years, only one local recurrence in the chest wall occurred and there was no regional recurrence. The distant metastatic rate was six percent. The long-term recurrence-free survival (RFS) rate was 80% at five years. The cause-specific survival rate was 90% at five years. No statistically significant correlation was found between the radiation dose administered and the outcomes. The overall survival rate was 55.5% at five years. There were 44 (88%) patients with Grade 1 or 2 early toxicity, consisting mainly of dermatitis. There was no Grade 3 or higher acute toxicity registered. Late toxicity was mainly Grade 1 or 2 subcutaneous fibrosis, lymphoedema, and brachial plexopathy, except for one patient with Grade 3 fibrosis.

Conclusions: Extreme LR HFRT is well tolerated with good outcomes and is a good alternative treatment for elderly and frail patients. Our results confirm the efficacy and safety of such a regimen in the setting where LR radiation is needed. Further randomized controlled trials (RCTs) assessing both oncologic outcome and toxicity profile are justified.

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ROLE OF ADJUVANT RADIOTHERAPY IN THE MANAGEMENT OF UROTHELIAL CARCINOMA OF UPPER URINARY TRACT –– A SYSTEMATIC REVIEW

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Purpose: Over 90% of tumours of the renal pelvis and ureter or upper tract are of urothelial origin (UTUC). The primary management is radical nephroureterectomy and nodal dissection but five-year CSS for pT4 UTUC is 12% and 35% when nodes are involved. Recent reviews suggest a survival benefit of chemotherapy; however, role of adjuvant radiotherapy (RT) remains uncertain. We conducted a systematic review to determine existing evidence regarding role of RT.

Materials and Methods: Medline/PubMed, Embase, Cochrane and Google Scholar databases were searched from 1990 to present. Duplicates were removed and non-English language articles translated. Inclusion criteria included transitional cell carcinoma, ureter or renal pelvis location, locally advanced disease and the use of RT. Single case reports and review articles were excluded. Studies with pediatric patients, recurrent or metastatic disease, distal urothelial cancers (bladder or urethra) or no adjuvant RT with curative intent were also excluded. Two independent reviewers (physicians) screened the studies to analyze for reported prognostic factors and outcomes.

Results: Seventeen eligible studies from 1991-2017 were identified, one prospective cohort and the rest retrospective with no randomized study. Twelve studies provided pathologic T and N staging and seven provided status of margin involvement. Out of a total of 6075 patients, 767 received adjuvant RT. RT techniques were conventional in four, 3D conformal in six and IMRT in one report with doses ranging from 35 to 66.6Gy in 2.2 to 1.8Gy per fraction. Target was mostly renal fossa, ureteral bed and nodal regions. Identified prognostic factors included grade, T stage, nodal involvement, margin positivity, adjuvant chemotherapy, RT and dose >50Gy. Seven studies reported improved outcomes with the addition of RT, particularly in terms of LRR. Adjuvant RT was a favourable prognostic factor in three studies, non-significant in two studies and unfavourable in two studies on multivariate analyses.

Conclusions: Multiple studies in this review suggested a benefit for RT in reducing LRR or improving CSS; however, a significant heterogeneity exists in terms of RT techniques and doses. There is a likely benefit of adjuvant RT among UTUC patients with pT3, pT4 and margin or node positive disease using modern RT techniques. Given a known benefit of RT in treating urothelial bladder cancer and poor outcomes associated with locally advanced UTUC there is need of a prospective study in evaluating the role of adjuvant RT among these patients.

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PROVINCE-WIDE ANALYSIS OF PATIENT REPORTED OUTCOMES FOR STAGE IV NON-SMALL CELL LUNG CANCER

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Purpose: Patient reported outcomes (PRO) evaluation through Edmonton Symptom Assessment System (ESAS) has been integrated into clinical workflow in Ontario, Canada, since 2007. As Stage IV non-small cell lung cancer (NSCLC) is associated with substantial disease and treatment-related morbidity, this province-wide study investigated moderate-to-severe symptom burden in this population.

Materials and Methods: ESAS collected from Stage IV NSCLC patients diagnosed between 2007-2018 linked to Ontario provincial healthcare system database were studied. ESAS acquired within 12 months following diagnosis were analyzed and the proportion reporting moderate-to-severe scores (ESAS ≥4) in each domain was calculated and plotted over time. Multivariable Poisson regression models with potential covariates such as age, sex, Elixhauser comorbidity index, income quintiles, and lung cancer treatments received were constructed to identify factors associated with moderate-to-severe symptoms.

Results: Of 22,799 patients, 13,289 (58.3%) completed ESAS (84,373 assessments) in the year following diagnosis. Patients with older age, high comorbidity, and not receiving active cancer therapy had lower ESAS completion. Majority (94.4%) reported at least one moderate-to-severe symptoms. Most prevalent were tiredness (84.1%), low wellbeing (80.7%), low appetite (71.7%), and shortness of breath (67.8%). Most symptoms peaked at diagnosis, while declining, remained high in the following year. On multivariable analyses, comorbidity, low income, non-immigrants, and urban residency were associated with moderate-to-severe symptoms ($p<0.05$). Moderate-to-severe scores in all ESAS domains were associated with radiotherapy within two weeks prior, while drowsiness, low appetite and wellbeing, nausea, and tiredness were associated with systemic therapy within two weeks prior ($p<0.05$).

Conclusions: In this province-wide analysis of Stage IV NSCLC PROs in the year following diagnosis, moderate-to-severe symptoms were highly prevalent and persistently high especially around cancer treatments, underscoring the need to address supportive requirements in this at-risk population. ESAS completion was lower among patients who are older, more comorbid, and not receiving active treatments, arguably more vulnerable patients facing barriers to complete in-person ESAS. Lowering barrier by implementing virtual PRO for early identification of symptom progression amenable to interventions is needed.

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THE READABILITY OF ONLINE CANADIAN RADIOTHERAPY PATIENT EDUCATIONAL MATERIALS

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Purpose: It is not clear if online radiotherapy patient educational materials that are published by the Canadian Cancer Society (CCS) and the various provincial health authorities meet the appropriate readability levels. The aim of this study is to determine the readability of online Canadian radiotherapy patient educational materials.

Materials and Methods: The publicly available educational materials were acquired from the provincial health authorities' and the CCS's websites. Only English language materials were included. Documents which mainly contained instructions or were part of interactive modules were excluded. The materials were transferred to Microsoft Word documents and labelled by source and category. Editing was then performed and the readability scores were acquired for each document.

Results: A total of 67 documents were included and four were excluded. The overall mean Flesch-Kincaid Grade Level from all sources was 7.5 (range, 3.6-13.2; 95% confidence interval [CI] 7.1-7.9), while the overall mean Flesch Reading Ease from all sources was 64.0 (range, 44.2-78.1; 95% confidence interval [CI] 62.0-66.1). The mean Flesch-Kincaid Grade Level scores from all sources were higher than the Grade 6 recommended reading level for patient educational materials. This difference was found to be statistically significant ($p\leq0.05$) for Alberta, New Brunswick, Quebec, and Nova Scotia.

Conclusions: Overall, the readability levels of online Canadian radiotherapy patient educational materials exceed the recommended grade 6 readability for patient educational resources. It is hoped that the findings of this study would inform and guide the future development and distribution of materials that meet the appropriate readability standards.

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TUMOUR VOLUME PREDICTS FOR PATHOLOGICAL COMPLETE RESPONSE IN RECTAL CANCER PATIENTS TREATED WITH NEOADJUVANT CHEMORADIATION

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Purpose: Currently, neoadjuvant chemoradiation (CRT) followed by total mesorectal excision is a standard treatment for patients with Stage II and III rectal cancer. However, non-operative management of rectal cancer is an emerging approach to allow patients to preserve their anal sphincter. Factors that may help identify patients most likely to have a pathological complete response (PCR) would be helpful for physicians and patients considering a non-operative approach.

Materials and Methods: A total of 377 patients from our institution who had clinical Stage II or III rectal cancer treated with neoadjuvant chemoradiation were included in the analysis. Patients were grouped based on their PCR status. Clinical parameters including overall stage, gross tumour volume (GTV), and radiation dose were analyzed by univariate and multivariate analysis, with PCR being the dependent variable. A receiver operator characteristic (ROC) curve was generated in order to identify a tumour volume cutoff with the highest sensitivity for predicting PCR.

Results: The cohort had a median age at diagnosis of 61 years, 68% were male, and 85% presented with Stage III disease. Sixty-eight of the 377 patients (18%) included in our analysis achieved PCR. A tumour volume of <18.7cc is highly sensitive (90%) for predicting pCR. Additionally, on multivariate analysis, a GTV of <18.7cc (odds ratio (OR) = 3.1, 95% confidence interval (CI) = 1.613-6.356, p=0.001) was significantly associated with an increased rate of pCR. Overall stage (p=0.026) was also significantly associated with pCR, while prescribed dose (p=0.45) did not appear to impact pCR rates.

Conclusions: Our analysis identified GTB volume <18.7cc as a strong predictor for PCR in Stage II and III rectal cancer patients receiving neoadjuvant chemoradiation, which will be helpful in identifying potential candidates for non-operative management.

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SYSTEMATIC REVIEW AND META-ANALYSIS OF RADIOTHERAPY FOR T3N0 RECTAL CANCER TREATED WITH TOTAL MESORECTAL EXCISION

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Purpose: The use of radiotherapy (RT) for T3N0 rectal cancers is suggested in national guidelines as this subgroup has been included in modern clinical trials demonstrating a benefit in reducing local recurrence (LR). However, no clinical trial has specifically examined the benefit in LR for this subgroup which may portend a baseline lower risk. Therefore, this meta-analysis seeks to determine whether RT reduces the risk of LR in patients with T3N0 rectal cancers managed with total mesorectal excision (TME).

Materials and Methods: All studies published up to October 18, 2020 were identified via PubMed and EMBASE searches. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were observed for a literature search, study screening and data abstraction. The Newcastle Ottawa Scale was used to evaluate study quality. Both processes were performed independently by at least two observers. Studies that reported LR data that included T3N0M0 rectal cancer patients and had comparator arms with and without RT use were included. Reviews, non-English articles, and studies not explicitly commenting on the intent to perform TME were excluded. Data was pooled using a random-effects model. The primary outcome of measure was relative LR.

Results: A total of 7,246 studies were screened, 134 full-text studies assessed for eligibility and five studies were included in the final analysis with the years of publication ranging from 2002-2020. No randomized data reported results specific to our study population. Five retrospective cohort studies involving 932 participants reported local recurrence outcomes. The median follow-up ranged from 38.4 months up to 71 months. Three studies were published in or after 2019. Four studies took place in Asia (797 participants) and one in North America (135 participants). Two studies provided RT exclusively neoadjuvantly, and three provided RT exclusively adjuvantly. Three studies provided exclusively concurrent chemoradiotherapy. The cumulative estimated relative risk for LR at five years was 0.63 (95% Confidence Interval 0.31 – 1.29; I2=41.8%) with RT as compared to no RT.

Conclusions: This meta-analysis' findings support that there is no clear benefit LR with the addition of RT in T3N0 population of patients with rectal adenocarcinoma undergoing TME. This meta-analysis was limited by potential bias due to the inclusion of retrospective cohort studies and use of subgroups.

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THE USE OF PROTON PUMP INHIBITORS DOES NOT ADVERSELY INFLUENCE PATHOLOGICAL AND CLINICAL OUTCOMES WHEN USED WITH CAPECITABINE IN THE NEO-ADJUVANT CHEMO-RADIATION TREATMENT OF LOCALLY ADVANCED RECTAL CANCERS

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Purpose: Capecitabine (Cape), an oral prodrug of 5-Flurouracil (FU) is routinely used for the neo-adjuvant chemo-radiation treatment (NACRT) of locally advanced rectal cancers. Investigators have reported that the concomitant use of Proton Pump Inhibitors (PPIs) may affect the efficacy of Cape, although the true effect of PPIs when used with Cape as a radio-sensitizer for NACRT is unclear. The aim of our study was to evaluate the impact of concurrent PPI use along with FU and Cape based NACRT in terms of pathological and oncological outcomes, in patients with locally advanced rectal cancers.

Materials and Methods: Rectal cancer patients treated at our centre between 2010 and 2016 were included in the study. We identified all patients who completed curative intent NACRT and examined the post-operative pathology and follow-up outcomes for any differences, in relation to the use of PPIs concurrently with FU and Cape based NACRT regimens.

Results: This study included 508 patients. Thirty-one (10.2%) and 20(9.8%) out of 304 and 204 patients were on PPIs during NACRT with FU and Cape respectively. No difference in pathological complete response was noted between the two arms with the concurrent use of PPIs (p=0.633). At a median follow-up of five years, no statistical difference in local or distant control was also noted with PPI use (p=0.094 and 0.632 respectively). The three-year overall survival was similar for FU and Cape (74.2% and 75% respectively) with concurrent PPI. Multivariate analysis showed no association of PPI use with Local control HR=0.802, CI=0.086-7.451, p=0.846 and HR=0.001, CI=0.00-∞, p=0.988 for FU and Cape respectively) or Overall Survival (HR=0.966, CI=0.321-2.907, p=0.951 and HR=1.179, CI=0.249-5.579, p=0.835 for FU and Cape respectively).

Conclusions: Our study revealed that there was no adverse pathological or oncological outcome with the concurrent use of PPIs along with Cape based NACRT in the treatment of locally advanced rectal cancers. We report that it may be safe to use PPIs if essential, in this clinical setting, while exercising caution.

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CONVENTIONAL VERSUS HYPOFRACTIONATION RADIATION FOR HIGH RISK PROSTATE CANCER PATIENTS (CHIRP): 24 MONTHS PATIENT-REPORTED QUALITY OF LIFE OUTCOMES OF THE RANDOMIZED PHASE II CHIRP TRIAL

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Purpose: The CHIRP study is a randomized phase II clinical trial that compared clinical outcomes between standard fractionation (78Gy in 39 fractions) and hypofractionation (68Gy in 25 fractions) in the treatment of high-risk prostate cancer. We performed a quality of life (QoL) sub-study to assess patient-reported outcomes up to 24-months post therapy.

Materials and Methods: Men with high-risk prostate cancer (Stage T3/T4 and/or PSA ≥20ng/ml and/or Gleason score 8 to 10) without clinical or radiological evidence of nodal or distant metastases were included in the CHIRP trial. QoL data was collected through the Expanded Prostate Cancer Index Composite (EPIC) and the Short Form 12 (SF12) health-related QoL questionnaire at baseline, three months, six months, 12 months, 18 months and 24 months post treatment. We assessed change from baseline (follow-up score minus bassline score) to account for differences in baseline comorbidities. Analysis of Variance (ANOVA), using a significance level of 0.05, was used to identify differences between the two groups.

Results: Ninety-six participants were included in the QoL sub-study, with 49 patients in the hypofractionation arm and 47 patients in the standard fractionation arm. Baseline urinary function favoured patients in the standard arm (p=0.04). All other baseline QoL parameters were balanced. At three months (p=0.155), six months (p=0.197), 12 months (p=0.016) and 18 months (p=0.120) post treatment, the bowel bother scores trended to favour the standard fractionation arm, and was statistically significant at 12 months (p=0.016). At six months (p=0.187), 12 months (p=0.063) and 18 months (p=0.017) post treatment, the SF12 physical component score (PCS) trended to favour the hypofractionation arm, and was statistically significant at 18 months (p=0.017). At 24 months, there were no differences in QoL scores between the two groups.

Conclusions: The patient-reported QoL scores were similar between the standard fractionation arm (78Gy in 39 fractions) and the hypofractionation arm (68Gy in 25 fractions) up to 24 months after radiotherapy. Early statistically significant differences in bowel bother and physical component score were no longer present at 24 months.

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ELECTIVE NODAL ULTRA HYPOFRACTIONATED RADIATION FOR PROSTATE CANCER: SAFETY AND EFFICACY FROM FOUR PROSPECTIVE CLINICAL TRIALS

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Purpose: The role of elective nodal irradiation (ENI) in localized prostate cancer (PCa) is controversial. With the increasing use of SBRT to the prostate, data is needed regarding the safety and efficacy of ENI using ultra-hypofractionated radiation (UHRT).

Materials and Methods: Between 2013-2020, four prospective clinical trials of intermediate or high-risk PCa receiving dose-escalated RT to the prostate (via either HDR brachytherapy or SBRT boost) and ENI using UHRT (25Gy in five weekly fractions) were conducted. Primary endpoints included acute genitourinary and gastrointestinal toxicities (CTCAE v3.0/4.0), and secondary endpoints included late genitourinary and gastrointestinal toxicities and biochemical failure (Phoenix definition).

Results: One-hundred sixty-five patients were enrolled, of whom 98 (59%) had high risk disease. ADT was used in 141 (85%). Median follow-up was 38 months (IQR 10-63). The worst acute genitourinary and gastrointestinal toxicities respectively were 48% and 7.5% for Grade 2, and 2.7% and 0% for Grade 3. Cumulative incidence of late Grade 2+ genitourinary and gastrointestinal toxicities at 36 months were 58% and 11.3% and for late Grade 3+ toxicities were 1% and 0%, respectively. No Grade 4+ acute or late toxicities were observed. The three-year biochemical recurrence-free survival was 98%.

Conclusions: ENI using UHRT is associated with low incidence of Grade 3+ toxicity, while Grade 1-2 acute genitourinary and gastrointestinal toxicity is common. Randomized Phase 3 trials are needed.

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INFECTIOUS RISK AFTER PROSTATIC TRANSRECTAL FIDUCIAL MARKER IMPLANTATION IN RADIATION THERAPY

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Purpose: The aim of this study is to report the infection risk in transrectal ultrasound-guided fiducial marker (FM) insertion for image-guided radiotherapy (IGRT) in prostate cancer.

Materials and Methods: Between January 2016 and December 2020, 835 patients scheduled for intensity-modulated radiation therapy for treatment of prostate cancer had an intraprostatic FM transrectal implantation under ultrasound guidance by radiation oncologists specialized in brachytherapy. Patients had a standard oral prophylactic antibiotic with quinolone. If quinolone-resistant bacteria were detected at the time of the prostate cancer biopsies, the prophylactic antibiotic regimen was modified accordingly. The quinolone-resistant bacteria screening test was not repeated in this cohort of patients before FM insertion. The infectious complications were assessed with questionnaires at the time of planning CT and medical record reviewed. Toxicities were evaluated according to CTCAE v5.0.

Results: The median time between FM implantation and evaluation was 10 days (range, 0-165). Four (0.48%) patients experienced pollakiuria and painful urination after the procedure, one (0.12%) patient also had fever, but the infectious assessment was negative. Four (0.48%) patients developed urinary tract infection related to the procedure, mostly with quinolone-resistant bacteria (75%). Three had a Grade 2 infection, and one patient experienced a Grade 3 urosepsis by quinolone-resistant E. coli. The quinolone-resistance status was known for two patients (one positive and one negative) and was unknown for the other two patients prior to FM implantation.

Conclusions: Intraprostatic transrectal FM implantation for IGRT is well tolerated with a low rate of infection compared to the prostate biopsies' literature (2%-7%). Yet, an infection could be potentially fatal, and it is important to prevent sepsis with the appropriate antimicrobial prophylaxis. The necessity of repeating the quinolone-resistance test prior to FM insertion remains unclear and needs to be validated.

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ADHERENCE TO THE AMERICAN THYROID ASSOCIATION GUIDELINES IN THE MANAGEMENT OF DIFFERENTIATED THYROID CANCER: IMPACT ON SURVIVAL OUTCOMES

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Purpose: The study objectives were to evaluate practice adherence to the primary management of differentiated thyroid cancer (DTC) in accordance with the 2009 American Thyroid Association (ATA) guidelines and the impact on patients' outcomes.

Materials and Methods: A retrospective review of all DTC patients referred to our institution between 2009 and 2013 was conducted. Baseline characteristics, upfront surgical management, and use of adjuvant radioactive iodine (RAI) ablation and radical external beam radiotherapy (EBRT) were collected. Disease management was assessed for adherence to the 2009 ATA guidelines. Overall survival (OS) and cancer-specific survival (CSS) were estimated using the Kaplan-Meier method and compared with the log rank test.

Results: The cohort consisted of 1091 patients diagnosed with DTC during the study period (~65% of all diagnoses of DTC in British Columbia). Baseline characteristics: median age at diagnosis 50 years, female sex 73%, histology; papillary 91%, follicular 7%, hurthle cell 2%. Stage at presentation using the AJCC 7th edition was: I 58%, II 8%, III 21%, and IV 13%. In total, 104 patients (10%) received care that was inconsistent with the ATA guidelines. Five-year outcomes for management consistent with guideline recommended initial surgery +/- central compartment neck dissection versus non-adherence was OS 94% versus 85% (p<0.001) and CSS 98% versus 90% (p<0.001). Five-year outcomes for guideline recommended adjuvant RAI versus non-adherence was OS 94% versus 63% (p<0.001) and CSS 97% versus 85% (p<0.05). Five-year outcomes for guideline recommended radical EBRT versus non-adherence was OS 94% versus 74% (p<0.001) and CSS 97% versus 80% (p<0.001).

Conclusions: The majority of patients (90%) received appropriate care aligned with the ATA guidelines. In our population-based cohort, older age and male were factors associated with increased likelihood of receiving non-adherent care. Discordant care in each modality resulted in compromised OS and CSS, suggesting that more rigorous efforts should be made to adhere to the guidelines in order to improve survival for DTC patients.

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ASSOCIATION OF TUMOUR VOLUME AND OUTCOMES IN T3 LARYNX CANCER WITH ORGAN PRESERVATION

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Purpose: Organ preservation approaches in the treatment of locally advanced larynx cancers are widely used and consist of radiotherapy (RT) with or without concurrent systemic therapy (CRT). Analyses of the National Cancer Database suggest that at the population level, survival in this disease may be decreasing, as CRT became more widely adopted in lieu of total laryngectomy (TL). Tumour volume in T3 laryngeal tumours has been hypothesized as a variable to explain this finding, with higher volume associated with lower local control, though largely in the pre-intensity modulated radiotherapy (IMRT) era. The purpose of this study was to analyze outcomes for T3 laryngeal cancer treated with IMRT.

Materials and Methods: This was a national, multi-centre retrospective cohort study of patients diagnosed with American Joint Committee on Cancer (AJCC) T3 N0-3 M0 glottic and supraglottic cancers who underwent curative intent IMRT with RT alone or CRT from 2002-2018. Tumour volumes were calculated using a validated standardized approach by a Neuroradiologist. Primary predictor was tumour volume, primary outcome was local control (LC), and secondary outcomes included overall survival (OS), as well as late Grade ≥3 toxicities. The Kaplan Meier method was used to estimate time-to-event outcomes, with log-rank tests performed to evaluate for differences. Cox proportional hazard modelling was performed to evaluate for predictors of survival.

Results: Two hundred forty-six patients met inclusion criteria, including 147 glottic and 99 supraglottic cancers. At baseline, glottic patients were more likely to be male (87% versus 74%, p<0.01), have a fixed vocal cord (63% versus 40%, p<0.01), not have pre-epiglottic space invasion (6% versus 34%, p<0.01), be cN0 (83% versus 40%, p<0.01), and have lower grade tumours (20% versus 7%, p<0.01). Mean tumour volumes for glottic and supraglottic tumours were 5.0 (4.2-5.8) cc and 13.0 (10.3–15.6) cc, respectively. Univariable analysis showed systemic therapy was associated with lower risk of local failure (HR 0.49, 95%CI 0.24 – 0.99, p=0.05). Within the glottic cohort, tumour volume was not associated with local failure (HR 1.09, 95%CI 0.71 – 1.67, p=0.38), however having a local failure event was associated with increased feeding tube dependence (HR 2.52, 95%CI 1.05 – 6.02, p=0.04). Median local failure-free survival in the overall cohort was 28.5 months, with median OS 23.2 months. There was a trend towards improved local control in the supraglottic cohort compared to glottic patients (log-rank p=0.08), but the supraglottic cohort had significantly worse overall survival (log-rank p=0.02).

Conclusions: In this retrospective cohort study, there were baseline and outcome differences between patients with T3 glottic and supraglottic larynx cancer, with worse overall survival in supraglottic patients. Tumour volume was not associated with local control in the glottic cohort. These findings are pending further validation in a larger cohort and will be analyzed separately for supraglottic tumours.

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COMPARISON OF RECURRENCE WITH HIGH RETROPHARYNGEAL NODAL-SPARING RADIATION TECHNIQUE IN HPV-RELATED AND HPV-UNRELATED OROPHARYNGEAL CANCER IN THE IMRT ERA

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Purpose: Patients with HPV-related oropharyngeal cancers (HPV+OPC) are known to have a superior loco-regional control when compared to HPV-unrelated oropharyngeal cancers (HPV-OPC). The introduction of intensity-modulated radiation therapy (IMRT) has allowed dose painting and sparing of uninvolved high retropharyngeal nodes (RP), although the risks associated with such avoidance are unclear. We reviewed outcomes and patterns of recurrence in patients with oropharyngeal cancer (OPC) treated with IMRT in patients with HPV+OPC and those with HPV–OPC.

Materials and Methods: We retrospectively reviewed all adults with OPCs treated with curative intent IMRT ± chemotherapy from 2012-2017. HPV status was tested by p16 staining for all OPCs and patients were staged as per the TNM 8th edition. All patients were treated with high-RP sparing, meaning omission of the nodal basin from the caudal limit of C2 to the base of skull. Patients who did not complete prescribed treatments, with multiple primaries or with less than 3 months of follow up were excluded. Patients, disease, treatment and outcome data were retrieved. Date and location of local, regional, retropharyngeal and distant recurrences were recorded. Time to events, including RP recurrence-free survival (RP-RFS), regional recurrence-free survival (R-RFS) and overall survival (OS) were analyzed using the Kaplan-Meier method and log-rank test, for HPV+OPC versus HPV-OPC.

Results: A total of 240 patients with OPC with available p16 status were included in the final analysis. The median follow-up was 4.18 years (range 0.25- 8.46 years). Of these patients, 195 patients (81%) had HPV+OPC and 45 patients had HPV–OPC (19%). The median age was of 60 years (range 40 – 94.6 years) and 85.2% of patients were male. The most common primary subsite was the tonsil (66.5%), followed by base of tongue (32.8%) and soft palate (4.8%). Patients had Stage I disease in 43%, Stage II in 29%, Stage III in 18% and Stage IV in 10%; 84.6% of patients had nodal disease at the time of presentation. Concurrent systemic treatments were delivered in 74% of patients.

Overall, there were three patients (1.5%) with RP recurrences in HPV+OPC versus two patients (4.4%) in HPV-OPC. The two-year RP and five-year RP-RFS was 98% for HPV+OPC and 94% for HPV–OPC (p=0.169). The two-year and five-year R-RFS was 92%/89% for

HPV+OPC versus 80%/74% for HPV–OPC (p=0.015) and two-year and five-year overall survival was 92%/78% for HPV+OPC versus 81%/59% for HPV– OPC(p=0.009).

Conclusions: In conclusion, high-RP sparing IMRT technique is associated with less than 5% of isolated recurrence in the high RP nodal region, despite most patients presenting with involved nodal disease. Our data showed no statistically significant difference in the HPV+OPC versus HPV–OPC patients. Further studies are needed to confirm whether high-RP sparing RT may be safe, especially in patients with HPV+OPC disease, who are known to have a more favourable prognosis, to limit long-term morbidity in this subgroup of patients.

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RADIATION THERAPY OF ELDERLY PATIENTS WITH SQUAMOUS CELL CARCINOMA OF THE HEAD AND NECK – INSIGHTS FROM THE ANALYSIS OF THE BC CANCER REGISTRY 2007-2017

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Purpose: The management of elderly patients with squamous cell carcinoma (HNSCC) of the head and neck presents unique challenges. We examined the radiation therapy (RT) management and outcomes of a large-scale registry population spanning 10 years.

Materials and Methods: 1029 HNSCC patients (>70yo) treated with definitive RT from 2007-2017 were identified from the provincial registry. Patient characteristics were analyzed in relationship to hypofractionated (HF) and conventionally fractionated (CF) RT. KM analysis was carried out for overall survival (OS).

Results: Two hundred sixty-four (26%) female and 765 (74%) male. Four hundred twenty-seven (41%) aged 70-74, 297(29%) 75-79, remainder >80. Stages: I (200(19%)), II (192(19%)), III (146(14%)), IV (366(36%)). ECOG: 0/1 (347(34%)), 2/3 (142(14%)), unknown 542(53%). Sites: oropharynx 379 (37%), larynx 366 (36%), oral cavity 230(22%), other 56(5%). Patients were more likely to be aged 70-74, have Stage IV disease, and present with laryngeal or oropharyngeal cancer (p<0.0001). 578(56%) and 451(44%) received HF and CF, respectively. Median RT dose was 6000cGy (range 200-7400). Median OS was 48 months for both HF and CF (p=0.9). A poorer performance status (two versus 0 (HR 2.095 (CI 1.5-2.9)), three versus 0 (HR 2.89 (CI 2-4.2)) (p<0.0001)), increasing age (80-84 (HR 1.5 (CI 1.2-1.9)), 85-89 (HR 1.7 (CI 1.2-2.4)), 90-94 (HR 2.7 (CI 1.8-4.2)) (p<0.0001)), advanced stage (Stage II HR 1.4 (CI 1.1-1.9) (p=0.0064), Stage III HR 1.6 (CI 1.2-2.2) (p=0.0011), Stage IV HR 2.5 (CI 1.9-3.3) (p<0.0001)), and oral cavity (HR 1.5 (CI 1.3-1.9) (p<0.0001)) were prognostic for increased risk of death. HF versus CF was not statistically significant for a difference in OS.

Conclusions: There was no difference in OS between HF and CF RT in elderly patients with HNSCC. HF regimens are a feasible RT option that reduces the number and frequency of hospital visits and the total treatment duration, which is of particular interest during the COVID-19 pandemic.

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PATIENT REPORTED OUTCOMES AND COMPLICATIONS DURING HEAD AND NECK CANCER RADIOTHERAPY BEFORE VERSUS DURING THE COVID-19 PANDEMIC

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Purpose: This study compares patient reported outcomes (PROs) and treatment related complications during head and neck (H&N) cancer radiotherapy before (August 2019 to February 2020) versus during the COVID-19 pandemic (March 2020 to October 2020).

Materials and Methods: The MD Anderson Symptom Inventory – Head and Neck Module was used to assess H&N cancer patients' symptoms on a scale of 1 to 10 at baseline and weekly during radiotherapy. This study analyzed all H&N cancer patients undergoing curative intent radiotherapy who completed the baseline questionnaire and one or more questionnaire during radiotherapy. For each patient, the maximum symptom scores for each question during radiotherapy were calculated. Chi square and t-test was used to compare the two cohorts.

Results: There were 158 patients in the pre-pandemic cohort and 137 patients in the pandemic cohort. Median age was similar between the two groups (63.8 versus 63.2 years, p=0.05). The majority (80% versus 77%) of participants were male (p=0.5). There were more current smokers during the pandemic (20% versus 10%, p=0.03). Alcohol usage was similar between the groups (29% versus 27%, p=0.8). The majority of patients were ECOG 0/1 (90% versus 90%, p=0.3). Stage distribution was similar between the cohorts with just over half (57%) having T1-T2 tumours in both cohorts and 68% versus 75% having node positive disease (p=0.2). More patients received concurrent chemotherapy in the pandemic cohort (42% versus 58%, p=0.03). In both cohorts, the most common tumour site was oropharynx, followed by oral cavity and larynx.

The incidence of aspiration pneumonia pre-pandemic was 6% versus 3% during the pandemic (p=0.2). Hospitalization rate was 15% in both cohorts (p=0.9). There was a trend towards more patients requiring an NG or G-tube for feeding during the pandemic (21% versus 30%, p=0.07). The percentage of weight loss was higher during the pandemic (mean -5.6% versus 6.8%), but after accounting for differences in smoking and chemo usage between the cohorts, this was not statistically significant (p=0.18). The highest maximum symptom scores in both cohorts were pain (5.5 versus 5.6), fatigue (5.6 versus 5.7), lack of appetite (5.5 versus 5.9), xerostomia (5.8 versus 5.9), mucus (5.2 versus 5.6), dysphagia (5.8 versus 6.1) and dysgeusia (6.3 versus 6.7), all p>0.05. The maximum symptom scores were worse during the pandemic for vomiting, (1.8 versus 2.6, p=0.05) and choking/coughing on food (3.1 versus four, p=0.05) and this remained significant on multivariable analysis after accounting for differences in smoking and chemo usage between the cohorts.

Conclusions: Complication rates during H&N radiotherapy during the COVID-19 pandemic were similar at our institution relative to the pre-pandemic era. The majority of symptom scores were similar between both eras, but during the pandemic, patients reported more severe vomiting and choking/coughing, and this remained statistically significant after accounting for baseline differences between the cohorts.

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WORKFLOW AND INITIAL EXPERIENCE OF GLIOMA RADIOTHERAPY ON A HIGH FIELD 1.5 TESLA MR-LINAC

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Purpose: The development of high-field strength MR-guided radiotherapy systems enables daily MR imaging, the opportunity for adaptive radiotherapy, and functional imaging acquisition. This study reports the workflow implementation, treatment times, and initial experience of glioma radiotherapy on the 1.5T MR-Linac (MRL).

Materials and Methods: Selected glioma patients treated with concurrent chemoradiation (chemoRT) between October 2019 and August 2020 were identified from a prospective database. All patients were treated on the MRL with backup plans on conventional Linac if the MRL was unavailable. Workflow timings were recorded and online adaptive plans were generated using the Adapt-To-Position (ATP) workflow derived from a pre-beam T1-weighted MRI. Temporal variation within the FLAIR hyperintense region (FHR) was assessed by the Dice similarity coefficient (DSC) and relative FHR volumes, compared to the initial FLAIR contour at the first MRL fraction. Multi-parametric images were acquired on the MR-Linac during radiation treatment, including diffusion-weighted imaging (DWI), chemical exchange saturation transfer (CEST), magnetization transfer (MT), and blood oxygenation level dependent (BOLD) resting-state fMRI. The behavior of selected functional parameter values was investigated within the FHR at the imaged fractions.

Results: Ten high grade glioma patients completed chemoRT to a median dose of 60Gy (range, 54-60 Gy) in 30 fractions (range, 30-33), receiving a total of 287 fractions on the MRL. The mean in-room time per fraction was 37.3 minutes (range, 24-51 minutes), and 42.9 minutes if including post-beam research imaging. Three patients (30%) required re-planning between fractions 15 to 19 due to progression of tumour and/or edema identified on daily MRL imaging. At the 10, 20, and 30 day post-first fraction time points, three, three, and four patients had a FLAIR volume that changed by at least 20% relative to the first MRL fraction, respectively. Multi-parametric images including DWI, CEST, MT, and BOLD resting-state fMRI were successfully acquired on the MR-Linac. The median apparent diffusion coefficients (ADC) within the FHR and volumes of FLAIR were significantly correlated when the data from all patients and time points were pooled ($r=0.68$, $p<10^{-3}$).

Conclusions: We report the first clinical series of glioma patients treated with chemoRT on the MRL. The workflow and treatment times were clinically acceptable, and daily online MRL imaging triggered adaptive re-planning for selected patients. Acquisition of multi-parametric imaging sequences was feasible on the MRL during routine treatment workflow. ADC parameter changes could be reliably tracked during chemoRT, and mature clinical outcomes data is anticipated to define the role of functional imaging in adaptive radiotherapy.

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HEARING LOSS AFTER RADIATION AND CHEMOTHERAPY FOR CENTRAL NERVOUS SYSTEM AND HEAD AND NECK TUMOURS IN CHILDREN

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Purpose: Hearing loss (HL) is a serious secondary effect of treatment for head and neck (H&N) and central nervous system (CNS) tumours in children. Radiation and platinum chemotherapy independently increase the risk of HL; however, combined modality treatment is routinely used and the effect of chemoradiation on HL risk is not well-studied. Using chemotherapy and cochlear radiation (RT) doses, we created a model that predicts for HL, including a nomogram that can be used in the clinical setting to calculate the risk of clinically-significant HL.

Materials and Methods: In this single institution retrospective study, 171 patients with H&N or CNS tumours were treated with radiation, with or without chemotherapy and had longitudinal (≥2) audiological evaluation. SIOP-Boston (SIOP) and Chang grades were assigned to 2,420 hearing assessments of 342 ears; analyses using SIOP grades are presented here.

For the nomogram, SIOP Grade ≥3 was considered clinically-significant HL (requiring hearing aids). An Andersen-Gill model for recurrent events was used to obtain inverse intensity weights to account for factors explaining the number of assessments. Multivariable weighted ordinal logistic regression was fitted to evaluate the effect of clinicopathologic features on HL. Clustered robust standard errors were calculated to account for intra-patient correlation.

Results: Patients underwent a median of six (range 2-23) assessments over a median of 3.1 years from diagnosis to last audiogram (range 0.1-15.2 years). Cisplatin was given to 63% of patients and 34% received carboplatin. The mean cochlear doses on the right and left were 36.8Gy (standard deviation [SD] 16.5) and 37.0Gy (SD 16.2), respectively. Multivariable regression revealed that mean cochlear dose (odds ratio [OR] 1.04 per Gy, 95% confidence interval [CI] 1.02-1.05, p<0.001), time since RT (OR 1.2 per year, 95% CI 1.2-1.3, p<0.001), cisplatin use (OR 5.33, 95% CI 2.9-9.9, p<0.001), and carboplatin use (OR 2.3, 95% CI 1.27-4.17, p=0.006) were associated with increasing SIOP grade of HL; age at RT, hydrocephalus, surgery, amifostine, and laterality were not correlated with HL. There was no synergistic effect of RT and cisplatin (interaction term, p=0.4) or RT and carboplatin (interaction term, p=0.9). Cumulative incidence of high-frequency HL (>4 kHz) was >50% at five years post-RT in those who received mean dose >20Gy to the cochlea, while incidence of HL across all frequencies continued to increase beyond five years post RT.

Conclusions: RT and chemotherapy have an additive, not synergistic, effect on HL risk. Mean cochlear radiation dose, time since radiation, and platinum chemotherapy use were associated with HL. The nomogram generated can guide survivorship care by multidisciplinary pediatric oncology teams with respect to audiology follow-up in an effort to that ensure suitable educational accommodations and assistive devices are in place.

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UNDERSTANDING END-OF-LIFE CANCER CARE IN CANADA: AN UPDATED 12-YEAR RETROSPECTIVE ANALYSIS OF THREE PROVINCES' ADMINISTRATIVE HEALTH CARE DATA

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Purpose: This is an updated, longitudinal analysis to our previous study comparing the quality of end of life (EOL) care in cancer patients across Canada. This project used identical cohorts and definitions to evaluate quality indicators for EOL care in British Columbia, Ontario and Nova Scotia in a 12-year time span.

Materials and Methods: This retrospective cohort study of cancer decedents between 2004–2015 used administrative health care data to examine health service quality indicators in Canada that

have been evaluated as important and high value evaluative measures to the quality of EOL care: emergency department use, in-patient hospitalization, intensive care unit admissions, physician house calls, home care visits and a death experienced in hospital. Crude and standardized rates were calculated. Two separate multivariable logistic regression models were utilized to evaluate the factors associated with the use of either supportive or aggressive care.

Results: Among the 376,108 cancer patients who died of their disease between 2004-2015, 50.1% died in hospital (lower than our previous study at 53.6%), with British Columbia once again having the lowest standardized rate of such deaths (47.7%). Ontario saw the greatest 12-year decrease of in-hospital deaths from 52.8% to 41.1%. Emergency department use at EOL ranged from 38.6% in British Columbia to 46.7% in Ontario. This measure stayed the same for Ontario and Nova Scotia while British Columbia experienced an increase. Of all patients, 11.7% received some form of aggressive care at the end of life (higher than our previous study at 8.7%) compared to the 49.8% of Ontarians and 55.3% of Nova Scotians who received supportive care. Those who were male, living in a lower neighbourhood income community or smaller community size were associated with a decreased likelihood of receiving supportive care. Rates of aggressive care use dropped in Nova Scotia from 2004 to 2015 (11.9% to 9.4%) but remained the same in Ontario (13.6% to 13.4%) and increased in British Columbia (7.8% to 8.7%).

Conclusions: We advocate for a call to action for national reporting of EOL indicators across Canadian provinces. We found strong evidence that despite the shift in focus to providing EOL care to oncology patients with supportive care measures, 50% of oncology patients are still dying in hospital and 11.7% of patients are subject to aggressive care measures that may be out of line with their desire for comfort care in a non-hospital setting. Residents of the poorest neighbourhoods or smallest communities continue to be less likely to receive supportive care services, highlighting an additional ongoing need to meet these disparities in access to palliative care services.

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PREDICTORS OF TOXICITY IN A RANDOMIZED STUDY OF HYPOFRACTIONATED VERSUS CONVENTIONAL RADIOTHERAPY FOR GLIOBLASTOMA: DOSIMETRIC ANALYSIS OF ORGANS AT RISK

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Purpose: A concern with hypofractionated versus conventional radiotherapy (RT) is the potential for excess toxicity from higher biological equivalent dose to organs-at-risk (OAR). The dosimetric predictors of toxicity of hypofractionation for glioblastoma have not been systematically studied. In this study, we analyzed OAR dosimetric predictors of toxicity in a randomized study of hypofractionated versus conventional RT for newly diagnosed adults with glioblastoma.

Materials and Methods: Data was taken from a noninferiority trial of 133 adults (age, 18-70 years) with newly diagnosed glioblastoma and ECOG performance score of 0-2 who were randomized between 60Gy in 20 versus 30 fractions post-operative RT. OAR constraints were determined using RTOG 0913 limits for the conventional arm and linear quadratic (LQ) calculated equivalent limits for the hypofractionated arm. The delivered plan's dosimetry to the OARs (brainstem, optic apparatus, retina, lens, cochlea, hippocampus, cerebrum) was correlated in an exploratory analysis with CTCAE toxicity, and compared between arms. Neurocognitive decline was assessed by correlating MMSE score decrease beyond three months post-RT with hippocampus and cerebrum doses. Symptomatic toxicity (Grade 2+) was correlated to the relevant OAR. Wilcoxon signed-rank test was used to compare dosimetric data with LQ model-derived constraints.

Results: In the conventional RT arm, the mean left hippocampus ($p=0.03$, R^2 0.131) and cerebrum ($p=0.004$, R^2 0.207) doses were significantly associated with post RT decline in MMSE while right hippocampus mean dose did not reach statistical significance ($p=0.07$, R^2 0.089). Mean left hippocampal dose of $\geq$55Gy and mean cerebrum dose of $\geq$34Gy were associated with ≥3 point decline in MMSE. In the hypofractionated arm, left hippocampus mean dose significantly correlated with a decline in MMSE ($p=0.01$, R^2 0.151), while right hippocampus ($p=0.24$, R^2 0.034) and cerebrum ($p=0.57$, R^2 0.008) mean dose were not significant. Regression analysis of mean left hippocampal dose of $\geq$28Gy was associated with ≥3 point decline. Twenty-eight subjects experienced Grade 2+ toxicity. OAR doses statistically significantly below protocol-allowable maximum doses correlated with lack of Grade 2+ toxicities across all OARs ($p<0.001$) in both arms. OAR doses in subjects with Grade 2+ toxicities were not statistically lower than protocol limits for optic apparatus, retina and cochlea in both arms.

Conclusions: In a randomized non-inferiority trial of hypofractionated versus conventional radiation for glioblastoma, the largest impact of hypofractionated RT appears to be left hippocampus mean dose, which correlated to decline in MMSE scores. Subjects with OAR doses significantly below protocol limits did not experience Grade 2 or higher toxicity. Routine contouring and dose constraint to the left hippocampus and cerebrum in the treatment planning of adults with glioblastoma is recommended.

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CERVICAL CANCER PATIENT REPORTED GASTROINTESTINAL OUTCOMES: INTENSITY/ VOLUMETRIC MODULATED VERSUS 3D CONFORMAL RADIATION THERAPY

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Purpose: To evaluate gastrointestinal (GI) patient reported outcomes (PROs) in cervical cancer patients treated with definitive radiotherapy (RT), comparing 3D conformal RT (3DCRT) versus intensity modulated /volumetric modulated arc therapy (IMRT/VMAT).

Materials and Methods: A retrospective analysis of cervical cancer patients treated with curative intent RT between 2015-2018 was performed. GI PROs were collected at baseline, during RT (acute), ≤12 weeks after RT (subacute), and >12 weeks after RT (late) using the Prospective Outcomes and Support Initiative (POSI) which includes validated questions from EPIC Bowel 2, PRO-CTAE, and EORTC QLQ CX24. GI PROs evaluated three symptom domains: bowel problems (BP), bowel bother (BB), and abdominal problems (AP).

Results: The cohort included 167 patients. The median age was 48 (27-86), 74% had squamous cell carcinoma, and 51% had FIGO Stage I/II disease. All patients received brachytherapy, 99% received a 45Gy elective pelvic dose, 31% had para-aortic fields, and 97% received concurrent chemotherapy. 100 (60%) patients were treated with IMRT/VMAT and 67 (40%) with 3DCRT. The median follow-up was 24 (5-67) months.

In the BP domain, mean changes in symptom scores compared to baseline for 3DCRT versus IMRT/VMAT were +2.29 versus +1.82 (p=0.55) during RT, +0.9 versus -1.15 (p=0.01) ≤12 weeks after RT, and +0.72 versus -0.82 (p=0.01) >12 weeks after RT. In the BB domain, mean changes in symptom scores compared to baseline for 3DCRT versus IMRT/VMAT were +3.58 versus +3.16 (p=0.67) during RT, +2.18 versus -0.10 (p=0.02) ≤12 weeks after RT, and +1.98 versus -0.03 (p=0.01) >12 weeks after RT. In the AP domain, mean changes in symptom scores compared to baseline for 3DCRT versus IMRT/VMAT were +2.52 versus +2.01 (p=0.32) during RT, +1.41 versus -0.38 (p=0.02) ≤12 weeks after RT, and +1.29 versus -0.31 (p=0.01) >12 weeks after RT.

On multivariable analysis 3DCRT was associated with greater mean changes in subacute and late symptom scores in BP (subacute 0.29 (0.08-0.51), p=0.01; late 0.22 (0.03-0.41), p=0.02), BB (subacute 0.32 (0.04-0.61), p=0.03; late 0.26 (0.03-0.48), p=0.03), and AP (subacute 0.27 (0.05-0.48), p=0.01; late 0.24 (0.08-0.40), p=0.01) compared to IMRT/VMAT. Age, smoking status, prior abdominal surgery, FIGO stage, RT volume (pelvic versus para-aortic), and use of external beam boost were not associated with symptom score changes (p>0.05). Three-year estimates of overall survival, local control, and regional control were 87%, 97%, 86% in the IMRT/VMAT cohort and 91% (p=0.32), 97% (p=0.99), and 92% (p=0.26) in the 3DCRT cohort, respectively.

Conclusions: Cervical cancer patients treated with IMRT/VMAT had significantly less worsening of their GI PRO symptom scores compared to baseline in all three GI domains ≤12 weeks and >12 weeks after RT. 3DCRT was associated with greater subacute and late patient reported GI toxicity.

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PATIENT-DERIVED XENOGRAFT ENGRAFTMENT PREDICTS ORAL CAVITY CANCER OUTCOMES

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Purpose: Patient-derived xenografts (PDX) can help identify oral cavity squamous cell carcinoma (OSCC) patients at risk for disease recurrence and optimize clinical decision-making. In this study, we develop and validate a prediction score for loco-regional failure (LRF) and distant metastases (DM) in OSCC that incorporates PDX engraftment in addition to known clinicopathological risk factors.

Materials and Methods: PDX models were generated from OSCC patients. Patients were scored as a "non-engrafter" if PDX formation did not occur within 6 months. Multivariable analysis (MVA) was used to identify predictors of LRF and DM. Factors retained in the final MVA were used to construct a prediction score and classify patients into risk groups using a 10-fold cross-validation approach.

Results: Overall 288 OSCC patients were analyzed. MVA identified pT3-4, pENE, and engraftment as predictors of LRF and DM. Patients whose tumours engrafted (n=198) were more likely to develop LRF (HR 1.98, 95% CI: 1.24-3.18, p<0.01), and DM (HR 2.64, 95% CI 1.21-5.75, p<0.01) compared to non-engrafters. A prediction score based on the aforementioned variables identified patients at high-risk (defined as having at least two of the three high risk features i.e. engraftment, pT3-4, or pENE) and low-risk for LRF (43.5% versus 26.5% at 5-years, p<0.001), DM (38.2% versus 8.4% at five years, p<0.001), and poorer five-year OS (34% versus 66%, p<0.001). The prediction model that included engraftment had the highest discriminatory capacity in the cross-validation analysis (AUC: 67.8 [63.5-72.9]), while removal of engraftment as a predictor resulted in a lower c-index (AUC: 62.7 [57.0-68.4]). In patients classified based on a clinical score only (i.e. presence or absence of pT3-4 and pENE), engraftment remained useful in identifying those with worse outcomes. Compared to non-engrafters, engraftment was associated with higher rates of DM (15.8% versus 5.4%, p<0.05) in clinically "high risk" patients as well as higher rates of LRF (31.9% versus 13.8%, p<0.05) in clinically "low risk" patients at five years. Finally, engraftment was associated with poorer five-year OS in both clinically "high risk" (36% versus 65%, p<0.05), and "low risk" patients (57% versus 78%, p<0.01).

Conclusions: A prediction score utilizing OSCC PDX engraftment, in conjunction with pT3-4 and pENE, improves the prognostic utility of existing clinical models and predicts patients at risk for LRF, DM and poor survival.

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YOUR VOICE MATTERS DURING COVID-19: EVALUATION OF DIGITAL DIVIDES ACROSS A TERTIARY CANCER CENTRE

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Purpose: Virtual care (VC) and electronic patient-reported experience measures (ePREM) have been systemically adopted during the COVID-19 pandemic to facilitate continuity of cancer care and quality improvement. Digital divides, defined as differential access and benefit from these tools, may exacerbate existing health inequities among patients. We aimed to evaluate digital divides through ePREM access, use, and responses during the pandemic.

Materials and Methods: Your Voice Matters (YVM), a provincially-mandated ePREM survey, was adapted to an online platform in September 2020 and emailed to patients after outpatient VC and in-person clinic visits at a tertiary cancer centre in Ontario. Patient age, gender, postal codes, and completed surveys from September-December 2020 were collated. Income was estimated using area-level averages from Statistics Canada 2016 census data. Socioeconomic status was mapped to area-level dimensions of the Canadian Index of Multiple Deprivation: residential instability (RI), economic dependency, ethnocultural composition (EC), situational vulnerability (SV). Higher factor scores per dimension correspond to greater marginalization. Two-sided Chi-squared and t-tests were used to compare demographics between VC and in-person patients with a significance threshold of p<0.001. Generalized estimating equations logistic regression models were used to assess associations between patient satisfaction and visit type, as well as demographics.

Results: YVM was emailed to 28% (10625/37835) of patients with a response rate of 21.8% (2321/10625). Mean and minimum income (x $10,000) were highest among responders (6.6, 1.5) compared to non-responders (6.3, 1.3) and those without email (6.2, 1.1). Comparing responders with VC (n=549) and in-person (n=1719) visits, the former had higher mean income (6.9 versus 6.5, p<0.001) and lower mean EC factor score (0.2 versus 0.4, p<0.001). Satisfaction with care received was not associated with visit type and satisfaction with VC logistics was not associated with demographics. Patients with higher EC scores were more likely to rate low satisfaction in the "culturally appropriate" (OR 0.69, 95% CI: 0.57-0.85) domain. Patients with higher SV scores were more likely to rate low satisfaction in the "physical symptoms" (OR 0.69, 95% CI: 0.51-0.94) domain, while patients with higher RI scores were more likely to rate low satisfaction in the "physical"

(OR 0.82, 95% CI: 0.69-0.98) and "emotional symptoms" (OR 0.88, 95% CI: 0.79-0.98) domains.

Conclusions: VC patients had positive experiences with visit logistics across demographics and their satisfaction with care was comparable to that of in-person patients. However, VC use and ePREM access, use, and responses were associated with income and socioeconomic status. Identifying populations vulnerable to digital health inequities will guide strategies to bridge the divides.

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EFFICACY AND TOXICITY OF STEREOTACTIC BODY RADIOTHERAPY FOR LOCALIZED PROSTATE CANCER: A FOURTEEN-YEAR STUDY

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Purpose: This is the first study of prostate SBRT to have patients with up to 14-year follow-up. In this study, we report outcomes for prostate robotic SBRT in 560 patients, with NCCN low-, intermediate- and high- risk disease. We report on biochemical disease-free survival (bDFS), toxicity and Quality of Life (QOL).

Materials and Methods: We studied 560 patients with organ-confined prostate cancer, treated with SBRT to dose of 35-36.25Gy in five daily fractions between 2006-2009. We included 45 high-risk patients who received a 18-21Gy SBRT boost after 45Gy to the pelvis with EBRT. Median follow-up was 150 months. The median age was 69 years, and median PSA was 5.58. Three hundred twenty-four patients were low-risk, 153 were intermediate-risk and 83 were high-risk. ADT was administered to 102 patients. Patients were further stratified into low-intermediate risk versus high-intermediate risk, with high-intermediate risk criteria of Gleason 4+3=7 or >1 intermediate risk factors (cT2b-c, PSA 10-20, Gleason 7). Biochemical failure was assessed using the Phoenix criterion. Cox regression analysis was used to determine which risk factors were significantly associated with increased risk of biochemical failure.

Results: Fourteen-year biochemical disease free survival was 91.3, 77.9 and 62.0% for low-, intermediate- and high-risk group patients, respectively. Local control was 96.7, 90.6 and 86% respectively. Favourable intermediate-risk patients had excellent outcomes, with no significant difference compared to low-risk patients with 14-year bDFS 87.1 versus 91.3%, (p=.35). Unfavourable intermediate-risk patients had outcomes similar to high-risk patients, with 14 year bDFS of 65.2 and 62% respectively. Median PSA fell to 0.1 after five years, where it remains. For low- and intermediate-risk patients, Gleason score was the only significant factor predicting for biochemical failure on multivariate analysis (p=0.0003), with ADT, dose and PSA not significant. For high-risk patients, PSA was the only significant predictor of bDFS (p=.01), with Gleason score, ADT or EBRT not significant.

Toxicity was mild. 36.25Gy was associated with more Grade 2-3 late urinary toxicity than 35Gy (14% versus 6%) (p=.01). Patients receiving EBRT had a higher rate of late Grade 2 late rectal toxicity. Mean EPIC QOL urinary and bowel domains for all patients declined during the first three months and then returned to baseline, where they remain. Mean sexual QOL scores have slowly declined by 47%.

Conclusions: This study suggests that early excellent control rates for SBRT for prostate cancer are durable over 14 years. Similarly, toxicity rates remain low and QOL scores remain high over that period. For patients receiving SBRT alone, 35Gy is as effective as 36.25Gy with less urinary toxicity, suggesting 35Gy may be the optimal dose. For high-risk patients, use of EBRT and ADT do not appear to increase long term control rates.

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INTERMITTENT ANDROGEN DEPRIVATION THERAPY PLUS COMPREHENSIVE STEREOTACTIC RADIOTHERAPY FOR OLIGOMETASTATIC PROSTATE CANCER (CROP)

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Purpose: The standard treatment for metastatic prostate cancer is systemic therapy. This prospective phase I/II study assessed the utility of SBRT to all tumour sites plus intermittent androgen deprivation therapy (ADT) in patients with hormone sensitive oligometastatic prostate cancer. Endpoints included incidence of SBRT induced late toxicities and clinical outcomes including cumulative incidences of developing biochemical progression, new metastases, restarting ADT, castration resistant prostate cancer (CRPC), and overall survival (OS).

Materials and Methods: Synchronous and metachronous metastatic disease presentations were eligible if there were ≤5 metastases, with ≤3 metastases in any one organ system. Conventional scans (CT/bone scan +/- MRI) were used to stage patients at baseline, although novel PET imaging was optional. SBRT was delivered to all sites of disease, including the prostate if not previously treated. SBRT dose was site dependent but was generally 30-35Gy in 5 fractions for lymph nodes and non-spine bone lesions, 24-28Gy in 2 fractions for spine, and 35Gy in 5 fractions to the prostate. ADT was started prior to or immediately after SBRT and was continued for one year before moving to an intermittent approach. ADT was to be restarted when the PSA reached ≥10ng/mL or earlier if clinically indicated (development of new metastases or rapidly rising PSA). Toxicity (CTCAE v4.0) and PSA measurements were collected every four months during follow-up. Conventional scans were performed at a minimum of once per year, but more frequent imaging was allowed at the discretion of the physician. Time zero was start of ADT or SBRT, whichever was earlier.

Results: Ninety-two patients with 158 metastases were accrued with a median age of 74 years. Median follow-up time was 37 months. Median baseline PSA was 8.5ng/mL (range 0.78 – 179.8). Thirty-nine (42%) patients had Gleason score of 8-10. Thirty-two (35%) patients had synchronous disease presentation. Fourteen (15%) patients were staged with PET imaging. Five (5%) patients developed late Grade 3 GU toxicity and six (7%) patients developed a late SBRT-induced bone fracture. There were no Grade 4/5 toxicities. Median PSA nadir was 0.02ng/mL. Fifty percent of patients reached a PSA nadir of ≤0.02ng/mL, while 92% of patients reached a PSA nadir of <1ng/mL. The cumulative incidence (CI) of biochemical progression (PSA nadir + 2ng/mL) was 54% at four years. The four-year CI of developing new metastases and local failure of irradiated sites was 42.8% and 7%, respectively. The four-year CI of restarting ADT and developing CRPC was 62%, and 25.2%, respectively. OS was 79% at four years.

Conclusions: The incidence of Grade ≥3 toxicity was low when combining SBRT with intermittent ADT for hormone sensitive oligometastatic prostate cancer. With >3 years of median follow-up, outcomes are promising compared to historical results of using ADT alone, particularly with regards to the development of CRPC.

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STEREOTACTIC RADIOTHERAPY BOOST FOR DE NOVO HEAD AND NECK CANCERS: A SYSTEMATIC REVIEW

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Purpose: Locally advanced head and neck cancers (HNCs) represent challenges to oncologists due to the difficulty in obtaining local control (LC). It is hypothesized that LC rates of conventional radiotherapy may be improved with the use of a stereotactic body radiotherapy (SBRT) or stereotactic radiosurgery (SRS) boost. We performed a systematic review of the safety and efficacy of SBRT/SRS boost in the definitive treatment of locally advanced HNCs.

Materials and Methods: The study followed PICOS (Population, Intervention, Control, Outcome, Study Design) and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines. Medline (PubMed), EMBASE and Cochrane Library databases were queried from inception until January 2020. Two authors independently reviewed all records for inclusion and exclusion, which resulted in nine articles that evaluated the role of SRS/SBRT boost in treatment of previously untreated HNCs following conventional radiotherapy. Dosimetric data including dose fractionation schemes of conventional and stereotactic radiotherapy, simulation details, organs-at-risk (OAR) constraints, acute and late ≥ Grade 3 toxicities as well as comparative outcome data including overall survival (OS), local control (LC), and progression-free survival (PFS) were extracted up to five years.

Results: Nine studies (eight retrospective, one prospective) met inclusion criteria, representing 454 mutually exclusive patients across subsites including oral cavity, nasopharynx, oropharynx, salivary gland, and hypopharynx. Conventional radiotherapy doses ranged from 35-75.6Gy, in 23-38 fractions, and stereotactic boost doses ranged from 7-15Gy in 1-6 fractions. OS and LC rates were available from seven studies. Median OS rates were 91% (90-95%) at one year, 84% (62-97%) at two years and 80% (75-91%) at three years. Median LC rates were 100% (92-100%) at one year, 90.5% (89-100%) at two years, and 91.5% (90-98%) at three years. Median PFS rates were 89% (80-98%) at one year, 78% (70-90%) at two years, and 82% (70-90%) at three years. Commonly reported late ≥ Grade 3 toxicities were mucosal ulceration (reported in two studies, n=32), dysphagia (reported in two studies, n=20), and osteoradionecrosis (reported in one study, n=9). There were six (6/454, 1.3%) instances of treatment-related Grade 5 toxicities reported in three of six studies; attributed to epistaxis (n=3/454, 0.7%), mucositis (n=1/454, 0.2%), osteoradionecrosis (n=1/454, 0.2%), and pontine necrosis (n=1/454, 0.2%).

Conclusions: SBRT/SRS boost following conventional radiotherapy for patients with previously untreated locally advanced HNCs showed acceptable local control and survival outcomes in comparison to historical data. However, late complications were observed, including six treatment-related Grade 5 toxicities, therefore careful patient selection is strongly advised. Further prospective studies are warranted to determine the safety and efficacy of stereotactic boost following conventional radiotherapy, prior to implementation into clinical practice.

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PROSPECTIVE NEUROCOGNITIVE FUNCTIONS OF PATIENTS TREATED WITH CONCURRENT NIVOLUMAB AND STEREOTACTIC BRAIN RADIOSURGERY FOR NSCLC AND RCC BRAIN METASTASES

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Purpose: Previous studies have suggested activity of anti-PD1 antibodies against brain metastases from non-small cell lung cancer (NSCLC) and renal cell cancer (RCC). Our investigator initiated Phase 2 trial examined the neuropsychological effect of combining nivolumab with radiosurgery (SRS) in the treatment of patients with brain metastases from NSCLC and RCC.

Materials and Methods: This is a multi-centre open-label trial (NCT02978404) in which patients diagnosed with NSCLC or RCC, having ≤10cc of un-irradiated brain metastases, no prior whole brain radiotherapy and no prior immunotherapy were eligible. Study treatment commenced with a dose of nivolumab (240mg or 480mg IV), which was continued until progression for up to two years at bi-weekly or monthly intervals. SRS (15-21Gy) to all visible un-irradiated brain lesions was administered within 14 days of the first dose of nivolumab (cycle 1). Patients were followed by brain MRI and CT scans of the chest, abdomen and pelvis. Neurocognitive assessment was performed using the Hopkins verbal learning test-revised (HVLT-R), the Trail Making Test (TMT) and the Controlled Oral Word Association Test (COWA).

Results: Twenty-six study patients (22 NSCLC and four RCC) were enrolled between August 2017 and January 2020. Patients had a median of two (1-9) brain metastases treated with SRS. The median diagnosis-specific graded prognostic assessment (GPA) score was 2 (1-3). Forty-two percent of the patients had received prior cytotoxic chemotherapy, and one patient had received prior brain SRS. PD-L1 status was known for 21 of the 22 NSCLC patients (12 with ≥50% PD-L1 expression (DAKO 22C3)). Median icPFS was 5.0 months (six intracranial progressions and nine deaths without progression in the brain). Accounting for death as a competing risk, the one-year cumulative incidence of intracranial relapse was 20%, whereas the rate of extracranial relapse was 48.3% at one-year. Median overall survival was 14 months.

Neuropsychological evaluation was completed in 16 and nine patients at three and six-month follow-up, respectively. Median age of the 16 patients was 63 (46-77). At three months follow up, there was no significant difference on the patient's mean performance in any of the neurocognitive assessments; a deterioration of ≥1 standard deviation in at least one assessment from baseline was observed in eight (50%) patients. At six months, participants significantly improved on the TMT- Parts A (p=0.04) and Parts B (p=0.03).

Conclusions: Neurocognitive assessments suggest that upfront SRS concurrent with nivolumab PD1 inhibition is safe. Patient neurocognitive function showed potential improvements in patients able to complete six-month assessments. A potential synergy between nivolumab and SRS loco-regionally within the brain may be present, leading to high intracranial control. However, the high rate of extracranial progression does not suggest an abscopal effect triggered by SRS during nivolumab.

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A PROGNOSTIC MODEL FOR PATIENTS WITH OLIGOMETASTATIC DISEASE TREATED WITH STEREOTACTIC BODY RADIATION THERAPY

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Purpose: Stereotactic body radiation therapy (SBRT) is an increasingly important modality in the management of patients with oligometastatic disease (OMD). Though prospective clinical trials have demonstrated the benefits of SBRT in a variety of oligometastatic settings, there is currently limited data to guide patient selection and provide long-term prognostic information for OMD patients. The purpose of this study was to create a clinical prognostic model for overall survival (OS) for OMD patients treated with SBRT.

Materials and Methods: A large, retrospective multi-institutional database of OMD patients treated with SBRT provided the data for model construction. Recursive partitioning analysis (RPA) was used to generate a prognostic model for OS that could account for complex interactions between baseline patient characteristics. The model was generated using a training set (75% of all samples) and internally validated using the reserved testing set. Model performance in the training and test sets were evaluated using log-rank tests, Harrell's C-statistic and time-dependent area under the receiver operating characteristics curve (AUC). All analyses were carried out in R.

Results: A total of 1,033 patients were included in the analysis. RPA for OS revealed three risk groups. The low-risk group consisted of younger (<55) patients with favourable primary sites (hormone receptor/Her2-positive breast cancer, colorectal cancer or renal cell carcinoma) as well as any patient with a prostate cancer primary; the high-risk group consisted of patients with any other primary site who presented with non-pulmonary OMD within 24 months of the diagnosis of the primary disease; and the intermediate-risk group consisted of all other patients. The five-year OS was 77.5 % (95% confidence interval: 63.1-91.9%), 32.3% (25.1-39.5%) and 12.1% (2.9-21.4%), respectively, for the low-, intermediate- and high-risk groups. Log-rank tests for difference in survival between the risk groups in both the training and test sets were highly significant ($p<0.0001$). The model possessed good discriminative power with a C-statistic of 0.68 and time-dependent AUC of 0.72 in the training set, and there was an expected small reduction in these statistics in the test set (C-statistic: 0.65, AUC: 0.67).

Conclusions: An internally validated prognostic model for OS with good ability to distinguish between low-, intermediate- and high-risk OMD patients was generated. Subsequent external validation will be undertaken to demonstrate the robustness of this model to new data.

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IMPACT OF STEREOTACTIC BODY RADIOTHERAPY (SBRT) IN OLIGOPROGRESSIVE METASTATIC DISEASE

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Purpose: There is increasing interest in using stereotactic body radiation therapy (SBRT) to areas of oligoprogressive metastatic disease (OPD) to allow for the prolongation of a patient's current systemic therapy regimen or delay the need to start a new regimen. The main objective of our study was to investigate the impact of SBRT on survival and the incidence of systemic therapy treatment switch in this group of patients.

Materials and Methods: A retrospective institutional review of patients treated with SBRT for OPD was performed. Patients were included if they received SBRT for 1-3 discrete progressing metastases, using a dose of at least 5Gy per fraction. The study aimed to calculate progression free survival (PFS), overall survival (OS), local control (LC) and incidence of treatment switch (TS). PFS and OS were calculated using Kaplan-Meier methodology, while LC and TS were determined using cumulative incidence to account for competing risks of death without progression.

Results: Eighty-one patients with a total of 118 lesions were treated with SBRT from July 2014-November 2020. Median SBRT dose was 40 (18-60) Gy in five (2-8) fractions. Patients with kidney, lung, and breast cancer constituted the majority of patients. The last systemic therapy prior to OPD was tyrosine kinase inhibitor (TKI) (30.9%), chemotherapy (29.6%), immunotherapy (12.3%), chemo/VEGF (8.6%), hormonal (6.2%), CDK 4/6 (2.5%). Ten percent were on surveillance for indolent metastatic disease. Median follow-up post SBRT was 14 months. Median OS and PFS were 25.1 (95% CI 11.2 – 39.1) months and 7.8 (95% CI 4.6-10.9) months, respectively. The cumulative incidence of local progression of treated lesions was 5% at one year and 7.3% at two years. Sixty patients progressed after SBRT (mostly distant failure) and 17 underwent additional SBRT for further OPD. Thirty-eight patients (47%) ultimately changed systemic therapy following SBRT; the cumulative incidence of TS was 28.5% at six months, 37.4% at one year, and 43.9% at two years. Overall, after SBRT there were 16 acute and two late, Grade 3 toxicities and no Grade 4 or 5 acute or late toxicity observed.

Conclusions: SBRT effectively controls locally progressing lesions but distant progression still occurs frequently. However, a sizeable number of patients can be salvaged by further SBRT or have minimally progressing disease that may not warrant an immediate initiation or switch in systemic therapy. This is illustrated by the fact that over half the patients did not require a TS at two years. Further prospective studies are warranted to validate the benefit of integrating SBRT with systemic therapy strategies for patients with OPD.

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A RETROSPECTIVE STUDY OF LOW-RISK, NODE-POSITIVE PATIENTS ELIGIBLE FOR THE CANADIAN CANCER TRIAL GROUP MA.39 (TAILOR RT) RANDOMIZED TRIAL OF REGIONAL NODAL RADIOTHERAPY

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Purpose: The benefit of regional nodal irradiation (RNI) in women with low-risk, node-positive breast cancer is uncertain. TAILOR RT enrolls breast cancer patients with 1-3 involved macroscopic nodes and a low risk Oncotype DX Recurrence Score (<18) to determine breast cancer recurrence-free interval (BCRFI) with and without RNI. We report BCRFI in a retrospective study of patients similar to those enrolling in TAILOR RT.

Materials and Methods: Patients aged 40-79 with pT1-2 pN1 (macroscopically node-positive) breast cancers were identified in a population-based database between 2005 and 2014. Eligible patients had BCS (breast-conserving surgery) or mastectomy and axillary lymph node dissection (ALND) with one to three positive nodes, BCS and sentinel lymph node biopsy (SLNB) with one to two positive nodes or mastectomy and SLNB with one positive node. To select a cohort of patients likely to have Recurrence Score<18, ER Allred 6-8/8 AND PR Allred 6-8/8 AND HER2-negative AND Grade 1-2 were used to approximate the Luminal A subtype. All patients were started on hormonal treatment. The primary endpoint of BCRFI, which was the time to any breast cancer

recurrence or breast cancer-related death, was analyzed using multivariate competing risks analysis.

Results: The cohort had 1,169 women with a median follow-up of 9.2 years. Radiation treatments were: none (151 treated with mastectomy alone), breast only (133) and loco-regional (885). Patients undergoing RNI had significantly younger age (median 62 versus 58 years), greater nodal involvement, and more chemotherapy (all p<0.05). The 10-year estimate of BCRFI was 90% without, versus 90% with, RNI (p=0.5). On multivariable analysis, RNI was not a significant predictor of BCRFI (HR=1.0, p=0.9).

Conclusions: For women with low-risk by standard pathological assessment, node-positive breast cancer, RNI was not associated with better outcome, which supports the non-inferiority design of TAILOR RT and ongoing enrolment to the trial.

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INTERNATIONAL EXPERT DELPHI CONSENSUS GUIDELINES FOR THE USE OF BOLUS IN POST MASTECTOMY RADIATION THERAPY

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Purpose: There is a global lack of consensus and therefore a wide variation internationally in the use of bolus during post mastectomy radiation therapy (PMRT). An international expert group was formed to generate Delphi consensus guidelines regarding the use of bolus during PMRT.

Materials and Methods: Following the creation of the expert panel, an initial survey was circulated to establish current practice. A systematic review on the topic and a physics/dosimetry summary were circulated prior to completion of two subsequent surveys. Results from each survey were shared prior to circulating the next survey. The surveys sought to establish a consensus regarding various indications and contraindications for the use of bolus during PMRT. In addition, several statements regarding bolus use were included to establish consensus. Agreement was graded using a Likert scale (1-5) with mean scores of less than two or more than four indicating consensus. Items with a lack of consensus will be discussed during a live teleconference to identify any additional areas of consensus.

Results: International Delphi consensus guidelines will be finalized in March 2021 and will be available for presentation at CARO 2021. Consensus has been reached on several items so far: PMRT bolus is indicated for all T4b-d and ypT4; bolus is indicated only in cases that the skin is at high risk of recurrence (on a case by case basis); bolus increases skin toxicity; there is not sufficient evidence to support that bolus increases local control; bolus should be placed at the time of CT-simulation to allow for accurate treatment planning and if it does not conform adequately to the chest wall, 3D printed bolus, or an equivalent conformal bolus, should be considered.

Conclusions: Final consensus guidelines regarding the use of bolus in PMRT will be available for presentation at CARO 2021.

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PREDICTORS OF LOCO-REGIONAL RECURRENCE AND SURVIVAL OUTCOMES IN BREAST CANCER TREATED WITH MODERN NEOADJUVANT CHEMOTHERAPY: A CONTEMPORARY ANALYSIS OF PATIENTS TREATED IN BRITISH COLUMBIA

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Purpose: To evaluate loco-regional recurrence (LRR) and survival outcomes in breast cancer patients treated with modern neoadjuvant chemotherapy (NAC).

Materials and Methods: Patients diagnosed between 2005-2016, ≥18 years with any clinical T and N stages who received NAC, primary breast (mastectomy or breast conserving surgery, BCS) and nodal surgery (axillary dissection, AxD, and/or sentinel node biopsy, SNB) were included. All patients managed with BCS received at least whole breast radiation. We excluded patients with Her-2 or hormone receptor-positive tumours who did not receive indicated systemic therapies. Pathologic complete response (pCR) was defined as no invasive or in-situ disease in the breast and nodes. Outcomes included loco-regional relapse-free survival (LRRFS), breast cancer-specific survival (BCSS), and overall survival (OS).

Results: The study comprised 949 patients (median follow up 6.5 years): 92% had cT2-4 and 72% had cN1-3 disease. Combined taxane and anthracycline-based NAC was used in 92% of cases. After NAC, 85% underwent mastectomy, 84% AxD, 86% loco-regional radiotherapy (LRRT), and 10% mastectomy without RT. Overall, 22% achieved pCR. Proportions of pCR by subtype were 3% in luminal A, 14% in luminal B, 27% in triple-negative (TN), and 35% in Her2-positive. Patients treated without LRRT were more often Her-2 positive, cT1-2 cN0, with pCR. After pCR, significant improvements in seven-year LRRFS (97% versus 93%, p=0.02), BCSS (91% versus 75%, p<0.001), and OS (87% versus 72%, p<0.001) were observed. On subset analysis by subtype, outcome differences between pCR versus no pCR were most significant in TN (LRRFS 96% versus 85%, p=0.03; BCSS 87% versus 64%, p=0.002, OS 78% versus 58%, p=0.001). Luminal B and Her2-positive subtypes had better BCSS and OS with pCR while Luminal A subtype outcomes were not influenced by pCR. Receipt of LRRT was associated with improved LRRFS (95% versus 88%, p=0.008). On multivariate analysis, factors associated with reduced LRRFS were Grade 3 histology (HR 5.0, 95% CI 1.48-16.6, p=0.009) and residual breast and nodal disease after NAC (ypT+ and ypN+ versus pCR; HR 7.0, 95% CI 2.2-22.0, p=0.0008). Predictors of lower BCSS and OS were age >50, Grade 3, cT3-4, lack of pCR, TN and Her-2 positive subtypes. Regional nodal RT was associated with improved LRRFS (HR 0.3, 95% CI 0.1-0.6, p=0.002), BCSS (HR 0.5, 95% CI 0.3-0.9, p=0.03), and OS (HR 0.5, 95% CI 0.3-0.8, p=0.004).

Conclusions: The likelihood of pCR in patients treated with modern NAC regimens in this population-based cohort are comparable to published reports and varied by molecular subtype. Patients with residual pathologic disease in both the breast and nodes had worse outcomes. Patients treated without LRRT had lower survival than those treated with LRRT, supporting the need for prospective studies to evaluate the safety of de-escalating RT after NAC.

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COMPARATIVE COVERAGE OF THE SUBCUTANEOUS LAYER IN THE BREAST AND CHEST WALL USING MONTE CARLO CALCULATION AT VARIOUS ENERGIES

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Purpose: Breast skin thickness is estimated to be 3mm from histological studies. The subcutaneous layer lies within the buildup region for megavoltage radiation treatment and is at risk of local recurrence in patients with breast cancer. Traditionally many centres have placed bolus for patients receiving chest wall radiotherapy (CW) but rarely so for the intact breast.

We compared using fine grid Monte Carlo calculations (MC), the V90 and V95 for chest wall (CW) and intact breast (BCS) at the 3-5mm depth, representing the subcutaneous layer for three different photon energies.

Materials and Methods: For each beam energy (6, 10 and 15 MV), one patient received CW RT and a second patient received breast RT. A high-resolution shell 3 to 5mm cropped back from the skin surface was created. EGSnrc Monte Carlo (MC) and Varian Eclipse AAA algorithm plans were calculated for each using a 1mmx 1mm x 1mm grid.

Results: The V90 and V95 for the 3-5 mm shell were better for CWRT than for breast RT at each energy. For 3 to 5mm MC, CW 6MV V90 95.8 %, V95 63.5 %, BCS 6MV V90 81.8 %, V95 44.7 %, CW 10 MV V90 92.6 %, V95 73.3 %, BCS 10MV V90 64.2%, V95 40.2 %, CW 15 MV V90 96.6%, V95 79.3%, BCS 15 MV V90 60.3%, V95 36.5%. Eclipse dosimetry correlated well with MC.

Conclusions: V90 and V95 coverage of the subcutaneous layer of the chest wall is higher than the corresponding breast for clinically relevant energies. This raises the question of why bolus is deemed to be important for routine chest wall RT when it is not used for routine breast RT.

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STEREOTACTIC PELVIC ADJUVANT RADIATION THERAPY IN CANCERS OF THE UTERUS (SPARTACUS): A MULTI-CENTRE PROSPECTIVE TRIAL EVALUATING ACUTE TOXICITIES AND PATIENT REPORTED OUTCOMES

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Purpose: Adjuvant radiation plays a significant role in reducing loco-regional recurrences in uterine cancers. Standard treatment consists of daily radiation for five weeks which can be challenging for patients and the healthcare system, especially during the COVID-19 pandemic. Hypofractionated radiotherapy has been evaluated and established in other pelvic malignancies. This study aims to evaluate the acute urinary and bowel toxicities, and patient reported outcomes following stereotactic hypofractionated adjuvant radiation for endometrial cancer.

Materials and Methods: This is a prospective phase I/II trial in which patients with endometrial cancer planned for adjuvant radiation received 30Gy in 5 fractions, every other day or once weekly. Treatment was delivered at two centres with volumetric arc radiation therapy with a body-vacuum immobilization, bowel enema and 3D image-guidance. Toxicity assessment, outcomes and patient reported quality of life (QOL, EORTC core QLQ-C30 and endometrial EN24) were collected at baseline, fractions (F) 3 and 5, and at regular follow-up intervals. Higher scores represent better global QOL/health status or worse symptoms (scale 0 - 100). Changes in QOL over time were investigated with linear mixed-effects models. A p-value threshold of 0.05 was used for statistical significance. A change in QOL score of ≥ 10 points was considered clinically significant.

Results: The median age of the 41 enrolled patients is 66 (range: 51 – 88). Histologies included 29 endometrioid adenocarcinoma, eight serous/clear cell, one carcinosarcoma, and three dedifferentiated. Thirty patients had Stage I disease while three had Stage 2 and eight Stage 3. Seven patients received sequential chemotherapy and 3 had additional vault brachytherapy. Median follow-up is nine months, with worst toxicity (GI or GU) of Grade 1 and 2 in 63% and 24% respectively. No patients have experienced a Grade 3 or higher toxicity. Patient-reported diarrhea and gastrointestinal domain scores were statistically significantly worse than baseline at F5 (mean paired difference = 27.2; 8.7, p<.005) and six weeks (mean paired difference = 7.9; 5.1, p<0.05), and returned to baseline levels at 12 weeks. The only clinically significant change (≥10) from baseline was in diarrhea at F5. There were no significant changes in urinary domain, overall health and quality of life scores. No loco-regional recurrences have been found; three patients recurred distantly, of which two died of metastatic disease.

Conclusions: Stereotactic hypofractionated radiation is feasible and well-tolerated with short-term follow-up. Longer follow-up and future randomized studies are needed to further evaluate this treatment.

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USE OF ROBOTIC HYSTERECTOMY IN INTERMEDIATE-RISK ENDOMETRIAL CANCER

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Purpose: Our previously published result on intermediate-risk endometrial cancer demonstrated higher recurrence associated with robotic surgery compared to laparotomy. In the study, only those who have received adjuvant radiotherapy were included, as the patients without adjuvant therapy were discharged from follow-up and only limited data on these patients was readily available. In addition, time interval between surgery and adjuvant radiotherapy may have had impact on the outcomes. In this updated study, we have included both patient groups with and without adjuvant therapy.

Materials and Methods: A single-centre retrospective study was conducted on patients with FIGO Stage I endometrioid-type endometrial cancer with intermediate risk factors as defined by PORTEC-1 (<50% myometrial involvement and Grade 2-3, or >50% myometrial involvement Grade 1-2), who have undergone hysterectomy and bilateral salpingo-oophorectomy at our institution between 2010 and 2015. Data on surgical and radiation treatments, as well as patient and tumour characteristics were

collected and correlated with clinical outcomes. Survival curves were generated with the Kaplan-Meier method and the log-rank test was used to compare survival outcomes.

Results: A total of 179 intermediate-risk endometrial cancer patients were identified. Median age at diagnosis was 64 years (range 40-89 years) and median follow-up was 5.1 years. Lymphovascular space invasion was identified in 39 patients (21.8%). Majority of patients (76.5%) underwent surgical staging with pelvic lymphadenectomy and 135 (75.4%) patients received adjuvant radiotherapy. Among the 82 patients (45.8%) who underwent laparotomy, two patients recurred, and among the 97 patients (54.2%) who underwent robotic surgery, nine patients recurred. Median time-to-recurrence was 2.1 years (range 0.3-5.4 years). Two patients died of the disease in each group, translating into five-year disease-specific survival of 96.4% and 97.1% in laparotomy and robotic surgery groups, respectively. There were no significant differences between the two groups in disease-free survival (p=0.40) or overall survival (p=0.054).

Conclusions: Regardless of the use of adjuvant radiotherapy, higher recurrence was found in those patients who underwent robotic surgery compared to laparotomy. Intermediate-risk endometrial cancer carries favourable prognosis despite the recurrences. Further evaluation with prospective studies is necessary to confirm the recurrence pattern observed in our study.

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INCIDENCE AND RISK FACTORS FOR EUTHANASIA OR PHYSICIAN-ASSISTED SUICIDE IN ONCOLOGY PATIENTS: A SYSTEMATIC REVIEW

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Purpose: In a growing number of jurisdictions, oncology patients may choose euthanasia or physician-assisted suicide (EPAS). A 2016 systematic review reported that 75% of U.S. and over 70% of Dutch and Belgian EPAS cases involved oncology patients. In the Netherlands and Belgium, the percentage of deaths among oncology patients via EPAS has been increasing. We investigated the incidence and risk factors for EPAS and EPAS requests in oncology patients.

Materials and Methods: A systematic review was performed following PRISMA guidelines. PubMed, Embase and Cochrane databases were searched for articles from January 2000 to April 2020. Search terms were related to suicide, euthanasia, assisted dying, assisted death, right to die, mercy killing, and cancer. Eligible studies reported incidence and/or risk factors for EPAS/EPAS request based on at least 50 oncology patients. Eligibility for inclusion was independently reviewed by two authors, with discrepancies adjudicated by a third. Data obtained included: study type, country, cancer diagnosis, number of eligible patients, inclusion criteria, follow-up length, incidence of EPAS or EPAS request, and odds ratios (OR) for risk factors for EPAS and EPAS request. ORs and p values were extracted from studies whenever possible and were otherwise calculated based on the data provided using chi-squared test.

Results: The search strategy identified 6519 results. Twenty-five abstracts were selected for full-text review and 10 studies were included for analysis. All studies reported incidence of EPAS/EPAS request and six studies reported risk factors for EPAS/EPAS request. Six studies were from the Netherlands, three from Belgium, and one from Canada. Inclusion period for studies spanned from 1996 to 2018. Half of the included studies were prospectively conducted. Incidence of EPAS in cancer patients ranged from 7% to 15% and EPAS requests ranged from 8% to 27%. Factors significantly associated with EPAS ($p<0.05$) in any study include Charlson comorbidity index >1 (OR 9.1), severe nausea (OR 5.8), palliative treatment goal (OR 5.6), severe vomiting (OR 5.1), and severe pain (OR 4.7). Factors significantly associated with EPAS request ($p<0.05$) in any study include advanced euthanasia directive (OR 34.9). palliative treatment goal (OR 5.0), depressed mood (OR 4.3), help needed with housekeeping (OR 3.8), and post-secondary education (OR 3.7).

Conclusions: Up to 15% of oncology patients choose EPAS. Potentially modifiable symptoms including severe nausea, vomiting, and pain are significantly associated with euthanasia in oncology patients.

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RE-EVALUATING SURGERY AND RE-IRRADIATION FOR LOCALLY RECURRENT PEDIATRIC EPENDYMOMA – A MULTI-INSTITUTIONAL STUDY

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Purpose: The goal of this study was to evaluate extent of surgical resection, and timing and volume of re-irradiation, on survival for children with locally recurrent ependymoma.

Materials and Methods: Children with locally recurrent ependymoma treated with a second course of fractionated radiotherapy (RT2) from six North American cancer centres were reviewed. The index time was from the start of RT2 unless otherwise stated.

Results: Thirty-five patients were included in the study. The median doses for first radiation (RT1) and RT2 were 55.8 and 54Gy, respectively. Median follow-up time was 5.6 years. Median overall survival (OS) for all patients from RT2 was 65 months. Gross total resection (GTR) was performed in 46% and 66% of patients prior to RT1 and RT2, respectively. GTR prior to RT2 was independently associated with improved PFS for all patients (HR 0.41, p=0.04), with an OS benefit (HR 0.26, p=0.03) for infratentorial tumours. Median PFS was superior with craniospinal irradiation (CSI) RT2 (not reached) compared to focal RT2 (56.9 months; log-rank p=0.03). All distant failures (except one) occurred after focal RT2. Local failures after focal RT2 were predominantly in patients with less than GTR pre-RT2.

Conclusions: Patients with locally recurrent pediatric ependymoma should be considered for re-treatment with repeat maximal safe resection (ideally GTR) and CSI re-irradiation.

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SURVIVAL OUTCOMES IN PRIMARY HEAD AND NECK ADULT SARCOMA: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Purpose: Head and neck sarcomas (HNS) are rare entities and confer substantial morbidity and mortality. Yet, the optimal management of HNS remains unclear. This study aimed to describe the epidemiology of HNS and to identify the most favourable treatment approach.

Materials and Methods: We performed a systematic review and meta-analysis based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, using the PubMed (Medline), EMBASE, and Cochrane Library databases, queried from 1990 until present. Articles in the English language reporting on survival outcomes of adult primary HNS patients treated with curative-intent were included. All estimates were weighted based on sample size. Analysis of variance (ANOVA) and two-sample t-tests were used as appropriate. Meta-analyses were performed using random effects models. This study was registered with PROSPERO, CRD42021220970.

Results: A total of 3652 articles were identified, with 42 articles reporting on 21228 patients, meeting inclusion criteria. Mean ± SD age was 56.7 ± 14.6 years with 14170 (67.0%) men and 6991 (33.0%) women. The most common locations included skin and soft tissues (n=12749, 63.3%), bones of skull and face (n=2256, 11.2%), and oral cavity (n=1775, 8.8%). The most common histologies included undifferentiated pleomorphic sarcoma (n=5065, 24.8%), osteosarcoma (n=2578, 12.6%), Kaposi sarcoma (n=2316, 11.3%), chondrosarcoma (n=2141, 10.5%), and hemangiosarcoma (n=2072, 10.1%). 5459 patients had early Stage I-II disease (76.9%) whereas 1643 had late Stage III-IV disease (23.1%). Most received surgery alone (n=10968, 61.0%), 3917 (21.8%) received surgery and radiotherapy (RT), 2173 (12.1%) received definitive RT/chemoradiotherapy (CRT), 811 (4.5%) received surgery and CRT, and 98 (0.5%) received surgery and chemotherapy. Negative margins were achieved in 6081 (76.5%). Mean ± SD follow-up was 55.3 ± 42.8 months. Weighted mean, two-, five-, and 10-year overall survival (OS) were 78.5 months, 75.9%, 63.2%, and 54.9% respectively. There was no significant difference in mean OS (p=0.674) or five-year OS (p=0.965) between patients who received surgery alone, multimodality treatment with surgery and RT/CRT, or definitive RT/CRT. Mean ± SD five-year OS was significantly higher with negative margins (62.7 ± 20.8%) compared with positive margins (22.7 ± 19.1%; p=0.001). Mean ± SD local recurrence rate (LRR) was 32.0 ± 13.0%. LRRs were 41.8% for definitive RT/CRT, 39.3% for surgery and CRT, 33.6% for surgery alone, 24.7% for surgery and chemotherapy, and 20.1% for surgery and RT (P=0.126).

Conclusions: In the largest HNS study to date, negative margins were associated with an improvement in OS. Multimodality treatment did not confer an OS benefit. Definitive RT/CRT may be associated with a higher LRR. Randomized trials are needed to establish the optimal treatment approach for HNS.

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OPTIMAL MANAGEMENT OF RADIATION PNEUMONITIS: PRELIMINARY FINDINGS OF AN INTERNATIONAL DELPHI CONSENSUS STUDY

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Purpose: Radiation pneumonitis (RP) is a dose-limiting toxicity for lung cancer patients undergoing radiotherapy (RT) and systemic therapy. As the optimal practice for diagnosis, management and follow-up for RP is variable, we sought to establish expert consensus recommendations.

Materials and Methods: International leaders in multidisciplinary thoracic oncology were invited to participate (n=31) in this Delphi consensus-building process. Following literature review on RP, open-ended questions related to knowledge, risk-reduction, diagnosis and treatment were generated for Round 1. Responses were used to generate 37 statements regarding RP diagnosis and management for Round 2. In this round, participants rated their agreement/disagreement with statements using a five-point Likert scale, with oncologists receiving a survey with two additional items focused on planning technicalities. Consensus was achieved once ≥75% of respondents agreed with a statement. A final round to establish consensus in unresolved areas is planned.

Results: Round 1 had a 74% response rate (n=23; 12 radiation oncologists, five clinical oncologists, six respirologists), and Round 2, a 61% response rate (n=19; 15 oncologists, four respirologists). Of the 37 Round 2 statements, 36 received greater than ≥75% agreement. By the end of Round 2, there was consensus opinion with agreement on the following: 1) risk stratification and mitigation should include patient factors (exposures, ILD, autoimmune and genetic conditions, COPD, emphysema, previous RT, and demographics); 2) minimizing RP risk through treatment planning (tight PTV margins, limiting dose to normal lung, dose/fractionation, IV contrast, motion management, IMRT/VMAT, daily imaging, and meeting constraints for V20 and MLD) should be utilized when possible; 3) diagnosis should be based on symptoms, exam, temporal relationship to treatment, imaging, and common toxicity grading scales; 4) Treatment of RP should be multidisciplinary, with oncologists and respiratory physicians, and should involve administration of oral steroids with gastroprotection, starting with 60mg PO prednisolone or equivalent, for a duration of two weeks, with a taper of 10mg in the daily dose per week, or for severe pneumonitis, IV methylprednisolone for three days before PO. Treatment adjuncts may include oxygen, inhalers, and antibiotics; 5) in differentiating drug-related pneumonitis versus RP, standard review of patients receiving immunotherapy, per ASCO/ESMO guidelines, is insufficient to identify early pneumonitis, and thus it would be helpful to develop guidelines which recognize the additive nature of toxicities.

Conclusions: Responses from international thoracic oncology experts highlight areas lacking consensus in the diagnosis and management of RP. These data will inform the development of final consensus statements to provide practical guidance on diagnosis and management of RP.

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CARDIAC CORONARY RADIATION DOSE AND PATIENT RISK FACTORS FOR PREDICTING MAJOR ADVERSE CARDIAC EVENTS IN PATIENTS WITH LUNG CANCER

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Purpose: Thoracic radiotherapy (RT) is a mainstay treatment for locally advanced non-small cell lung cancer (LA-NSCLC). Mean heart dose (MHD) and percent left anterior descending (LAD) receiving ≥15 Gy (LADV15) have been shown to predict major adverse cardiac events (MACE) in LA-NSCLC patients receiving thoracic RT. We sought to develop a clinically applicable MACE risk prediction score model, including both cardiac dosimetric and baseline risk factors.

Materials and Methods: Retrospective data from 748 consecutive patients with LA-NSCLC treated with curative intent between November 1998 to December 2013 were included. The data was split based on diagnosis date on December 1, 2010 to

allow external validation. Model development was performed on 500 consecutive patients diagnosed before December 2010 using multivariable Cox-proportional hazard model; backward elimination scheme (α=0.05) was used to select the predictors for the final model. Potential predictors were selected *a priori* based on prior literature: age, pre-existing coronary heart disease (CHD), Framingham Risk, hypertension (HTN), MHD, LADV15, use of intensity modulated RT (IMRT), and interaction between CHD and LADV15 (CHD:LADV15). Model performance was assessed by the Harrell's c-index and was internally validated using leave-one out cross validation (LOOCV). The model was applied to the remaining 248 consecutive patients from the initial cohort as the external validation "test" dataset.

Results: The development and "test" cohorts had median age 64 versus 66 years (p=0.02), 51.0 versus 50.4% females (p=0.88), and 89.4 versus 89.1% Stage III cancer (p=0.91). The final model incorporated CHD, HTN, LADV15, and CHD:LADV15 (β coefficients: 2.703, 1.129, 0.043, -0.047; all p<0.001; c-index 0.773). LOOCV Pseudo R^2=0.0195. The c-index on the external test dataset was 0.727. Actuarial overall three-year MACE rates for the development and test cohorts were 10.7% and 15.4%, respectively. Stratifying development cohort patients into terciles based on MACE risk prediction scores yielded three-year MACE rates of 0%, 5.7%, and 25.6% for lowest to highest risk-terciles, respectively. Among test cohort, the three-year MACE rates were 4.9%, 10.5%, and 31.9% for lowest to highest risk-terciles respectively.

Conclusions: The three-year MACE rates spans 5% to 32% from lowest to highest risk groups. Both LADV15 and pre-existing cardiac risk factors are important in predicting MACE risk post-thoracic RT. This tool has the potential to estimate personalized LADV15 constraints based on patient risk factors and acceptable MACE risk thresholds (i.e. 5-10%), thus may help identify patients who may benefit most from the application of advanced RT techniques to further reduce LAD dose as a modifiable risk factor during RT planning.

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PREDICTORS OF HIGHER RADIATION DOSE IN RECTAL CANCER PATIENTS TREATED WITH NEOADJUVANT CHEMORADIATION

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Purpose: Long-course neoadjuvant chemoradiation followed by total mesorectal excision (TME) is a standard treatment option for locally advanced rectal cancer. Currently, there is significant variability in radiation dose-schedules, with 5040cGy in 28 fractions being the most common. The aim of this retrospective study was to identify clinical and pathological factors that clinicians use in escalating radiation dose for these patients.

Materials and Methods: Patients with locally advanced disease (clinical T3/T4 or N1/N2) who received neoadjuvant chemoradiotherapy followed by TME were divided into two groups based on prescribed radiation dose: standard dose group (≤5040cGy) and high-dose group (>5040Gy). Clinical and pathological factors, such as patient age, tumour grade, overall stage, distance from anal verge and gross tumour volume on pretreatment MRI were analyzed against the prescribed radiation dose using univariate and multivariate analyses. A p-value of 0.05 was used for statistical significance.

Results: Three-hundred seventy-seven patients treated for locally-advanced rectal cancer at the Cross Cancer Institute (Edmonton, Alberta) between 2010 and 2016 were included in this analysis. One hundred ninety patients were in the standard dose group (median dose = 5040cGy) and 187 patients were in the high dose group (median dose = 5400cGy). Median age at diagnosis was 61, 68% were male, and 85% presented with Stage III disease. Higher clinical stage (p=0.034), higher tumour grade (p=0.014) and tumours <5cm from anal verge (p=0.003) were associated with higher prescribed dose. There was no correlation between prescribed dose and patient age (p=0.537) or tumour volume (p=0.193).

Conclusions: Higher clinical stage and tumour grade appear to influence the prescribed radiation dose. These results indicate that clinicians are likely to escalate radiation dose for more aggressive tumours. Radiation oncologists are also more likely to escalate dose in treating tumours close (<5cm) to the anal sphincter, potentially reflecting clinicians' desire for sphincter preservation.

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A NOVEL COMPOSITE BIOMARKER PANEL FOR DETECTION OF EARLY STAGE NON-SMALL CELL LUNG CANCER

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Purpose: Non-small cell lung cancer (NSCLC) is the leading cause of cancer-related mortality worldwide and a number of investigators have shown that early detection of lung cancer may improve survival by way of early treatment. This study investigated a novel composite methodology of using targeted serum microRNAs (miRNA) and urine metabolites for the accurate detection of early stage non-small cell lung cancer (NSCLC).

Materials and Methods: We recruited consecutively consenting early stage NSCLC patients and matched control subjects to provide samples of serum for miRNA studies and/or urine for metabolite analyses. Quantitative real-time reverse-transcription polymerase chain reaction (rtPCR) with exogenous control was used to measure Serum miRNA levels, and the comparative Delta Cycle Threshold (ΔC_T) method was used to calculate relative miRNA expression of two targeted miRNAs (miR-21 and miR-223). The concentrations of six targeted metabolites from urine samples of patients and healthy controls were measured using Proton Nuclear Magnetic Resonance (^{1}H-NMR) spectrometry. A composite methodology using both serum and urine biomarkers was then established using binary logistic regression, receiver operating characteristic (ROC) models with or without artificial intelligence (AI).

Results: The ROC analysis of miRNA expression yielded a sensitivity of 96.4% and a specificity of 88.2% for the detection of early stage NSCLC, with area under the curve (AUC)=0.91 (CI 95%: 0.80-1.0). Relative urinary concentrations of 4MPLA were significantly different between NSCLC and healthy control (p=0.008). The ROC analysis of 4MPLA yielded a sensitivity of 82.1% and a specificity of 88.2%, with AUC=0.85. The composite process combining miRNA and metabolite expression demonstrated a sensitivity and specificity of nearly 100% and AUC=1.

Conclusions: A highly specific, sensitive and non-invasive detection method for NSCLC was developed. Pending validation, this can potentially improve the early detection, and hence the treatment and survival outcomes of patients.

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LOCAL CONTROL IN TUMOUR-TARGETED DOSE ESCALATION FOR LOCALIZED PROSTATE CANCER: A REPORT ON THE TARGET STUDY

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Purpose: To report outcomes of dose escalation using a strategy of simultaneous integrated boost or HDR brachytherapy boost.

Materials and Methods: Eighty patients with localized prostate cancer with gross tumour volume (GTV) identified on multiparametric magnetic resonance imaging (mpMRI) were enrolled in this Phase 2 non-randomized trial between November 2012 and August 2016. Patients with GTV >5mm and less than 33% of prostate volume were eligible. All patients received whole gland prostate radiotherapy, 76Gy in 38 fractions using volumetric arc therapy (VMAT). GTV dose escalation was delivered by integrated boost VMAT (IB-VMAT) of 95Gy in 38 fractions (n=40); or MR-guided HDR boost of 10Gy in 1 fraction (n=40). Choice of dose escalation strategy was by physician and/or patient choice. The primary end-point was three-year local control rates determined by MR-guided biopsy and/or MRI alone. Toxicity data was collected, using CTCAE v.4.0. Risk group categorization was similar between the arms; 5% low-, 75% intermediate-and 20% high-risk. Three high-risk patients received six months ADT.

Results: Median follow-up was 55.2 months (IQR 48.1-71.4). The overall five-year biochemical failure-free survival was 92% (95% CI, 85-99), with five patients developing biochemical relapse (BCR) (one IB-VMAT; four HDR boost). There was no difference noted between boost strategies. Local control data was available for 66 patients who agreed to the three-year post-treatment biopsy (20) or MRI alone (46); 32 in IB-VMAT and 34 in HDR boost. Local control in the boost volume was achieved in 61 patients (92%). One patient in the IB-VMAT arm had persistent disease on biopsy, and subsequently developed late BCR. Intraprostatic relapse outside the GTV was seen in four patients at last follow-up; one treated with IB-VMAT and three with HDR boost. All four patients developed BCR. Late G2 genitourinary (GU) toxicity was 22.5% and 27.5% in IB-VMAT and HDR boost, respectively. Late G2 gastrointestinal (GI) toxicity was 5% with both boost strategies. Two G3 (one GI, one GU) toxicities were seen in IB-VMAT.

Conclusions: Dose escalation to intraprostatic lesions provided high rates of local and biochemical control with minimal severe late toxicity. There appeared to be an association between intraprostatic failures beyond the boost volume and BCR, suggesting dose escalation to other subclinical intraprostatic regions may be warranted. Identification of such regions will likely remain a challenge and characterization using molecular classification, beyond usual clinical parameters, may be needed.

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QUALITY OF LIFE OUTCOMES AFTER SALVAGE BRACHYTHERAPY FOR LOCALLY RECURRENT PROSTATE CANCER

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Purpose: Local salvage brachytherapy (BT) after previous radical radiotherapy (RT) in prostate cancer (PC) may cause additional toxicity and thus a reduction in quality of life (QoL). We report on QoL for patients treated in a prospective Phase 2 study.

Materials and Methods: From 2009 to 2020, 50 patients were treated for locally recurrent disease after RT for PC. Patients underwent MRI-guided HDR salvage BT (MRgHDRBT) in 2 fractions. Cohort 1 had whole gland treated with 16Gy with an integrated boost (wgBT) of 22Gy to GTV. Cohort 2 had focal HDR (fBT) to 26Gy. GTV was defined on multiparametric MRI. For wgBT the GTV-PTV expansion was 2mm except 4mm superior-inferior (s/i). For fBT, GTV-CTV expansion was 5mm restricted to within 2mm of the prostate and PTV of 2mm s/i. Toxicity was assessed using CTCAE v4 and the Expanded Prostate Cancer Index Composite (EPIC) for QoL at baseline and after HDR. Multivariable linear regression model accounting for repeated measurements within individual and adjusting for baseline score and time was fitted to compare cohorts and to assess association between dosimetry and EPIC.

Results: The median age was 71 (range 62,85) years with a median follow up of 60.5 (6,134) months. 37 (74%) patients underwent fBT, and 13 (26%) wgBT. Overall five-year biochemical control was 45.2% (95% CI 31.5, 64.9), 44.1% (95% CI 27.5, 70.8) for fBT and 46.2% (95% CI 25.7, 83.0) for wgBT. The median GTV-PTV volume, was 7cm (3.6,18.4) and 7.5cm (3.2,16.4) per fraction in fBT; compared with 3.4cm (1.1,8.5) and 4.1cm (0.9, 8) in wgBT. These volumes received a median PTV V100 of 98% in fBT and 100% in wgBT. The median dose D0.5 cc in fBT compared to wgBT was 8.4Gy versus 9.5Gy for the urethra, 5.4Gy versus 7Gy bladder and 8.6Gy versus 7.3Gy rectum.

In the fBT group 23 (62%) patients had Grade 1 GU toxicity, and two (5%) Grade 2; compared with five (38%) and eight (62%) in the wgBT cohort, respectively. Grade 1 GI toxicity developed in four (11%) patients with no G2 after fBT, whereas in the wgBT, four (31%) and three (23%) patients reported G1 and G2 GI toxicity. Of the 17 (34%) patients who remained adequate sexual function before salvage, six (35%) developed G1 toxicity and three (17.6%) patients had G2 (five and one patient in fBT group, respectively). No Grade 3 toxicity was reported.

Scores in QoL demonstrated a decrease at month one which recovered by month three and was stable for urinary ($p<0.001$) and bowel ($p=0.013$) while sexual function continued declining during follow-up; with higher scores for fBT ($p=0.018$).

Conclusions: Salvage MRgHDRBT was a safe and well-tolerated treatment with minimal adverse effects on urinary and bowel QoL measures but detrimental to sexual QoL. Further analysis with larger sample size might clarify the complex relationship between dose-volume, toxicity and QoL.

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A PROSPECTIVE STUDY OF MR-GUIDED FOCAL SALVAGE HIGH DOSE-RATE BRACHYTHERAPY FOR RADIORECURRENT PROSTATE CANCER: UPDATED RESULTS OF 30 PATIENTS

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Purpose: Salvage therapies for localized radiorecurrent prostate cancer often carry significant short- and long-term morbidity. Focal salvage high dose rate (HDR) brachytherapy is an appealing treatment technique which delivers an ablative dose of radiotherapy to the portion of the prostate containing recurrent disease; however, limited prospective data is available. We sought to explore the toxicities, health related quality of life and efficacy of focal salvage HDR brachytherapy after previous definitive radiotherapy.

Materials and Methods: Patients with locally recurrent prostate cancer after previous external beam radiotherapy (EBRT) and/or brachytherapy were enrolled on a prospective clinical trial. Patients received MRI-guided, ultrasound-based focal HDR brachytherapy delivered over two fractions of 13.5Gy delivered one to two weeks apart. Adjuvant androgen deprivation therapy (ADT) was not used. Toxicity was measured using CTCAE v4. Post treatment response was evaluated using MRI one to two years after salvage. Biochemical failure was defined as PSA nadir + 2ng/mL.

Results: Thirty patients were treated between November 2012 and September 2019. Median follow-up was 35 months (range: 13 – 92 months). Fifteen patients were initially treated with EBRT, three with low dose rate (LDR) brachytherapy monotherapy, one with EBRT and LDR brachytherapy boost, two with EBRT and HDR brachytherapy boost, and nine with HDR brachytherapy as monotherapy (all 19Gy in a single fraction). Median clinical target volume (CTV) at time of salvage was 5.22mL (range: 2.18 – 15.71mL), corresponding to a median of 20.0% of the prostate volume (range: 8.8 – 39.2%). Median PSA at salvage was 4.46ng/mL (range: 0.99 – 11.63 ng/mL). The median CTV V100 was 96.5% (range: 90.5 – 99.5%), and median CTV D90 was 15.1Gy per fraction (range: 13.6 – 18.1Gy). Seventeen patients experienced subsequent biochemical failure, and nine have received ADT and/or further local salvage. No patients have died from prostate cancer. Median time to biochemical failure was 41.5 months, and median time to ADT/salvage therapy was 70.6 months. The three-year biochemical failure-free event rate was 61.8% (95% CI 44.0 – 86.6%), and three-year ADT/salvage therapy-free event rate was 86.0% (95% CI 74.1 – 99.8%). No acute Grade ≥3 GU/GI toxicity was observed. One late Grade 3 GU toxicity event occurred, cystitis at 42 months post treatment, which did not persist on follow-up. No late Grade ≥3 GI toxicity was seen. Of the 28 patients who had a post-treatment MRI, 26 had evidence of a local treatment response.

Conclusions: In our updated results, we found focal salvage HDR brachytherapy is well tolerated with a favourable side effect profile and three-year biochemical control rates in line with other salvage therapies for radiorecurrent prostate cancer. While early MRI response at the treated site is common, this does not preclude subsequent biochemical failure.

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DOSIMETRIC COMPARISON IN MALIGNANT GLIOMA PATIENTS CLINICALLY TREATED ON HYBRID MAGNETIC RESONANCE IMAGING (MRI)-LINAC (MRL) VERSUS CONVENTIONAL LINAC

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Purpose: The Magnetic Resonance Imaging (MRI)-Linac (MRL) is a hybrid machine integrating a high field strength 1.5T MRI with a linear accelerator, providing superior soft tissue visualization of tumours and organs-at-risk (OARs) during treatment delivery. A special consideration for MRL radiotherapy is accounting for interactions of secondary electrons generated within the magnetic field, which can alter dose deposition at air-tissue interfaces. We evaluated dosimetric outcomes in clinically treated malignant glioma patients who received at least one fraction of radiotherapy on both the MRL and a conventional Linac.

Materials and Methods: Thirty-seven glioma patients treated on both the MRL and a conventional Linac for adjuvant chemoradiotherapy between July 2019 and February 2021 were analyzed. Planning was completed on treatment planning systems (TPS) using a Monte-Carlo algorithm that accounts for magnetic field effects (Monaco v5.40) for the MRL, and a convolution-superposition algorithm (Pinnacle v9.8) for the conventional Linac. Dosimetric parameters of interest from the target, OARs, and air-tissue interface volumes for each patients' clinical treatment plans were extracted and compared. For 10 representative patients, in vivo skin doses during a single fraction of MRL and conventional Linac treatment were obtained using an Optically Stimulated Luminescent Dosimeter (OSLD) placed in a defined location on the patient's skin near the Planning Target Volume (PTV). Student's t-test and Wilcoxon signed-rank test were used to compare parameters between Monaco and Pinnacle. Spearman's correlation was used to assess the relationship between in vivo OSLD measurements and TPS skin dose. Threshold for statistical significance was $p<0.05$.

Results: Most patients were treated for high grade glioma (76% Grade III or IV, 24% Grade II), and median PTV was 257.4cm^3 (range, 37.1-570.3cm^3). MRL and conventional Linac had similar V100, V95, D98, and D95 for PTV, and D3cc for optic chiasm, optic nerves, and each cochlea (p=NS). However, clinically delivered Monaco plans had significantly greater doses within air cavities (mean Dmean higher by 1.3Gy, $p<0.0001$) and skin (mean Dmean higher by 1.9Gy, $p<0.0001$; mean D2cc higher by 8.1Gy, $p<0.0001$; mean V20Gy higher by 7.2cm^3, $p<0.0001$), compared to clinically delivered Pinnacle plans. In vivo OSLD skin readings were 14.5% greater for treatments delivered on the MRL ($p=0.0027$), and were more accurately predicted by Monaco ($r=0.95$, $p<0.0001$) versus Pinnacle ($r=0.80$, $p=0.0096$).

Conclusions: In this prospective study of clinically treated glioma patients on both MRL and conventional Linac, the dosimetric impact of the magnetic field was minimal for the target and standard OARs. However, higher doses to skin and air cavities were observed. In vivo correlation of dose to skin was more accurately predicted with Monaco. Future MRL planning processes are being designed to account for skin dosimetry and treatment delivery.

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AFTER ASCENDE-RT: OUTCOMES OF ANDROGEN DEPRIVATION, EXTERNAL BEAM RADIATION AND LDR BRACHYTHERAPY BOOST FOR HIGH-TIER INTERMEDIATE AND HIGH RISK PROSTATE CANCER TREATED AT BC CANCER KELOWNA

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Purpose: The 2017 publication of the ASCENDE-RT Trial demonstrated the efficacy of trimodality treatment in high-risk prostate cancer patients. Despite superior biochemical progression-free survival (b-PFS), the treatment was associated with higher GI and GU toxicities compared to external beam alone. We analyzed patients treated in a similar manner in Kelowna in the years following accrual to ASCENDE-RT to see if outcomes and toxicity rates remain comparable outside a clinical trial selected population.

Materials and Methods: Ninety-nine consecutive patients treated with EBRT and LDR boost between 2010 and 2016 at BC Cancer Kelowna were reviewed. Survival analysis was conducted using Kaplan Meier Estimate. IPSS scores were patient reported. GI and GU toxicities were graded per the LENT-SOMA Scale.

Results: There were 42 high-tier intermediate-risk and 57 high-risk prostate cancer patients. Median follow up was 6.1 years (1.9-9.8 years). Eighty-one percent received ADT for a mean duration of 11.7 months (IQR = 9.75-12). Twelve patients developed biochemical failure with five and eight years b-PFS of 89% and 85%. Median PSA at four years was 0.05 (IQR = 0.02-0.1). Mean IPSS decreased by 0.4 at three years from baseline but was the same at five years. Cumulative late Grade 2 and Grade 3 GU toxicity rates were 4%

and 3% while the respective GI toxicity rates were 3% and 1%. The urethral stricture rate was 3%.

Conclusions: EBRT with LDR boost continues to demonstrate excellent b-PFS in both high-tier intermediate risk and high-risk prostate cancer patients. Unlike reported results for ASCENDE-RT, late GU and GI toxicities along with urethral stricture rates were extremely low with >5 years of median follow-up.

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BREAST DEFORMATIONS MEASURED WITH CONE BEAM COMPUTED TOMOGRAPHY DURING ADJUVANT RADIOTHERAPY FOR BREAST CANCER

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Purpose: This study aims to assess breast deformations during adjuvant radiotherapy for breast neoplasms with cone beam computed tomography (CBCT) and to correlate the deformations with characteristics of the tumour and the treatment plan.

Materials and Methods: Patients were eligible if they had histologically confirmed breast cancer treated with adjuvant radiotherapy. Breast deformations were assessed by two radiation oncologists after image registration between the planning computed tomography (pCT) scan and CBCTs obtained during treatment. The variabilities of the position of the breast at the level of the tumour cavity and at the isocenter were measured. Variabilities less than 5 millimeters (mm) were given a score of 1, between 5 and 10 mm a score of 2 and higher than 10mm a score of 3. Contractions were given a negative sign and dilatations a positive sign. Tumour characteristics and details of the treatment plan were collected retrospectively.

Results: Fifty-six patients treated in our institution between March 2013 and October 2015 are included in this analysis. At the start of treatment, there were breast contractions at level of the tumour cavity in 38.9% of the participants and breast dilatation in 46.3% compared to the anatomy of the pCT. Seventy-eight percent of the participants had a breast deformation of less than 5mm and 9% had a deformation between 5mm and 10mm. Deformations remained stable during treatment in 40.4% of patients. There is a correlation between the volume of the tumour bed and the probability of observing a deformation on the first CBCT (p=0.01). The mean tumour cavity was 13.2 cubic centimeters (cc) when the deformations were less than 5mm at the first CBCT and 38.3cc when the deformations were greater than 10mm. Tumours located in the lower outer quadrant of the breast were associated with more deformations during treatment than tumours located in the other quadrants (p=0.04). Smaller deformations at the end of radiotherapy were correlated with longer delays between surgery and the end of the radiotherapy (p=0.03), with a mean of 92 days when the deformations were less than 5mm and 67 days when de deformations were greater than 5mm.

Conclusions: The increase in the volume of the tumour cavity, the localization of the tumour in the lower outer quadrant of breast and a smaller delay between surgery and the end of the radiotherapy correlate with breast deformations during radiotherapy. These results, combined with the planned dose, could be used to target patients who might benefit from a closer monitoring of their positioning during treatment.

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APOPTOSIS AND SENESCENCE IN LOCALIZED PROSTATE CANCER TISSUES TREATED WITH HDR-BT BOOST WITH RADIOTHERAPY (EBRT) AND ADT

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Purpose: High dose rate brachytherapy HDR-BT boost with external beam radiotherapy (EBRT) and adjuvant Androgen Deprivation Therapy (ADT) is an effective treatment of localized prostate cancer (PCa). Ionizing radiation (IR) delivered by BT or by EBRT induce DNA damage leading to cell death by activation of apoptosis. On the other hand, ADT can also induce apoptosis or senescence depending the duration of treatment. The goal of this study is to determine which signaling pathway is activated in PCa cells in response to the DNA damage induced by HDR-BT boost with EBRT and ADT.

Materials and Methods: Thirty patients with localized PCa signed an informed consent to participate in this clinical pilot study. Ten patients were treated with only HDR-BT / EBRT alone (no ADT group) and twelve patients also received additional ADT (ADT group). Eight patients were excluded from the study because their biopsy specimens did not contain representative cancer areas. The expression of Ki-67 and p53, pro-apoptotic markers Bax and PUMA and p16 as a senescence marker were analyzed by immunohistochemistry in the biopsies taken from all patients before and post-treatment.

Results: Our results show an up-regulation of pro-apoptotic markers and reduction of senescence marker expression in the tissues treated by HDR-BT/ EBRT. However, we noticed an increase expression of senescence marker p16 and no change in pro-apoptotic markers receiving additional ADT.

Conclusions: HDR-BT/ EBRT treatment alone induces apoptosis in PCa cells while additional ADT appears to promote their senescence. This could explain the mitigated benefit of ADT to improve radiation treatment combined with BT. These results need to be validated in a larger cohort of patients.

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CRANIAL RADIOTHERAPY AS SALVAGE TREATMENT IN RELAPSED PRIMARY CNS LYMPHOMAS: A SINGLE-CENTRE RETROSPECTIVE ANALYSIS

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Purpose: Primary CNS lymphoma (PCNSL) is a rare disease accounting for 3% of all CNS malignancies. Standard of care for PCNSL is upfront high-dose methotrexate (HD-MTX) chemotherapy for eligible patients, while cranial radiotherapy (RT) is reserved for salvage. In this retrospective study, we aimed to investigate the safety and efficacy of salvage cranial RT.

Materials and Methods: Patients diagnosed with PCNSL, who received upfront HD-MTX chemotherapy and salvage cranial RT after disease relapse between 1995 and 2017 were selected. Patient demographics and treatment data were collected and radiological response to cranial RT was assessed.

Results: A total of 23 patients were selected (median age 59.9 years) and 21 patients received salvage cranial RT, among which 47.6% achieved complete response and 42.9% achieved partial response. Patients who had response to chemotherapy were more likely to achieve complete response (62.5%) than those who did not (30.7%). Higher dose to the whole brain (>30Gy) was associated with higher rate of complete response (53.3%) than lower dose (≤30Gy, 33.3%), while boost dose to the gross disease was associated with higher rate of complete response (57.1%) compared with no boost dose (28.6%). Four patients (19.0%) sustained at least Grade 2 treatment-related neurotoxicity.

Median overall survival, defined as time from the start of salvage RT to death, was 20.7 months (range 1.9 to 147.0 months) among the entire cohort.

Conclusions: PCNSL patients who relapsed following upfront HD-MTX chemotherapy showed a high rate of response to salvage cranial RT, especially those receiving >30Gy to the whole brain. Further study is necessary to elucidate the role of salvage cranial RT in these patients.

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NOVEL USE OF OPTICAL SCANNER AND 3D PRINTING TECHNOLOGY IN NASAL SKIN TUMOURS. A LOOK INTO CLINICAL OUTCOMES – A CASE SERIES

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Purpose: Single field Orthovoltage radiation is an acceptable modality used for treatment of nasal cutaneous cancer. This technique though has dosimetric pitfalls and unnecessary excessive exposure of radiation to organs at risk (OAR). We present clinical outcome of a case series of cutaneous nasal tumours using a novel technique incorporating optical scanner and three-dimensional (3D) printer to deliver treatments using parallel opposed (POP) fields.

Materials and Methods: The POP delivery method was validated using ion chamber and phantom measurements prior to implementation. A retrospective chart review of 26 patients treated with this technique between 2015 and 2019 was conducted. Patients' demographics and treatment outcomes were gathered and tabulated. These patients first underwent an optical scan of their face to gather topographical data. The data was then transcribed into 3D printing algorithms and positive impressions of the faces were printed. Custom nose block bolus was made with wax encased in acrylic shell; 4cm thick using the printed face models. Custom lead shielding was also generated. Treatments were delivered using 250 KeV photons POP arrangement with 4cm diameter circle applicator cone and prescribed to mid plane. Dose and fractionation was as per physician discretion.

Results: Phantom measurements at mid plane were found to match the prescribed dose within ±0.5%. For the 26 cases in this review, median age was 78.5 years, with 15 females and 11 males. Eighty-five percent of cases had basal cell carcinoma (BCC); one case had squamous cell carcinoma (SCC), one had synchronous BCC + SCC and one had Merkel cell carcinoma. Twenty-one cases had T1N0 disease, four had T2N0 and one had T3N0. Dose and fractionation delivered was 40Gy in 10 fractions for majority of cases. Complete response rate at median follow-up of six months was 88%; one patient had refractory tumour and one patient had recurrence. Toxicities were minor with 81% with no reported side effects. Three patients experienced Grade 3 skin toxicity.

Conclusions: Utilization of optic scanner and 3D printing technology along with innovative approach of using POP orthovoltage beams allows effective and efficient way of treatment carcinomas of the nose with high control rate and low toxicity profiles.

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A SYSTEMATIC REVIEW OF INTRAFRACTION PATIENT MOTION DURING LINEAR ACCELERATOR-BASED SPINAL RADIATION THERAPY

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Purpose: The safe and effective delivery of spine stereotactic body radiotherapy (SBRT) is contingent on meeting a variety of guideline-endorsed technical requirements. Of critical importance is motion management and immobilization during treatment delivery given the proximity of these targets to the spinal cord. We aimed to systematically review and synthesize the findings from studies that measured intrafraction motion during spine radiotherapy, using several common immobilization strategies.

Materials and Methods: A systematic review of MEDLINE and Embase (inception to December 2020) was performed using PRISMA guidelines. We included English language studies that examined intrafraction motion of immobilized humans treated with spinal external beam radiotherapy (RT). Trials were included that reported intrafraction motion in translational and/or rotational planes, while using an independently reported form of immobilization. CyberKnife, phantom, animal studies, non-spine targets, fiducial-based studies, and studies of set-up error were excluded. Studies were grouped by immobilization type, and relevant data were abstracted.

Results: Seventeen studies (14 papers, three abstracts) were included, representing 424 patients and 465 treated lesions. Publication dates ranged from 2003 to 2017, with the majority (n=11) from North America. Studies were primarily of retrospective design (n=16) and included SBRT and conventional dosing as well as primary and metastatic spinal tumours. Four studies reported absolute translations, 13 reported directional translational motion. Only six studies reported detailed rotational data.

Initial setup tolerances, ranged from ≤1mm in translational dimensions, and ≤1 degree in rotational dimension to ≤3mm and ≤3 degrees, respectively. Imaging verification (intra- and post-treatment) was primarily through onboard Cone-Beam Computed Tomography (CBCT). Between 1-5 verification CT scans were completed. Treatment times ranged from 10-90 minutes.

Immobilization types included: BodyFix (six studies; 138 patients), Custom Stereotactic Body Frame (CSBF) (eight; 139), Vac-Lock (four; 111) and Thermoplastic Mask (TM) (five; 36). Weighted mean motion in BodyFix studies reporting absolute motion (n=4) was (lateral: 0.51mm, cranial-caudal (CC): 0.58mm, anterior-posterior (AP): 0.48mm). Heterogeneity in reporting and small sample sizes by immobilizer precluded further pooled analyses. Range of reported means in studies reporting directional means, by immobilizer type was: CSBF (lateral: -0.2 to 0.4mm, CC: -0.3 to 0.4mm, AP:-0.4 to 0.8mm) and Vac-Lock (lateral: -0.2 to 0.3, CC:-0.2 to 0.3, AP: 0.0 to 0.5).

Eleven studies either reported no deviations beyond 2mm, or recommended a planning target volume (PTV) of ≤2mm provided BodyFix or CSBF device was used, and daily treatment position verification with CT. Five studies using BodyFix or CSBF reported no deviations beyond 1.5mm or suggested PTV margins of <1.5mm may be safe.

Conclusions: Although heterogeneous, the studies identified in this review demonstrate limited mean intrafraction motion using the immobilization devices examined. Collectively, these data support the feasibility of a 2mm PTV margin for spine SBRT. These findings should serve only as guidance as ultimately PTV margins should be determined by individual medical physics departments based on institutional technology and quality assurance measurements.

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MANAGEMENT DELAYS IN LOW-DOSE-RATE BRACHYTHERAPY ARE ASSOCIATED WITH AN INCREASED INCIDENCE OF RECURRENCE AND METASTASES IN INTERMEDIATE-RISK PROSTATIC CARCINOMA

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Purpose: Previous studies have shown that increased wait times for prostatectomy for intermediate-risk prostatic carcinoma (PCa) lead to poorer outcomes. However, the impact of wait times for low-dose-rate brachytherapy (LDR-BT) are unknown.

Materials and Methods: Four hundred sixty-six consecutive patients with intermediate-risk prostate cancer that underwent LDR-BT at a single comprehensive cancer centre between 2003 and 2016 were retrospectively reviewed. The delay to definitive therapy (wait time) was calculated as the time from biopsy to LDR-BT treatment. Cox and Fine-Gray regression were used for analysis of outcomes. Covariates were NCCN risk-group (favourable versus unfavourable intermediate), IMPD-90 (continuous), and patient age (continuous).

Results: Median (interquartile range) follow-up for the cohort was 97 (75-124) months. Median wait time was 5.1 (3.9-6.9) months. Median patient age was 65 (60-69) years. Median pre-treatment PSA was 7.1 (5.4-9.2) ng/mL, 345 (75%) had T1 disease, 78 (17%), 332 (71%) and 56 (12%) had Grade group 1, 2 and 3 disease, respectively. In total, 296 (64%) had favourable and 170 (36%) had unfavourable intermediate-risk disease. Median D90 at time of implantation was 190 (185-194) Gy.

Wait time was not associated overall survival on univariate [univariate hazard ratio (UHR) 6.9 versus 3.9: 0.93 (0.80-1.08); p=0.340] or multivariate [multivariate hazard ratio (MHR) 6.9 versus 3.9: 0.91 (0.78-1.07); p=0.253] modelling. Increased wait time was associated with higher cumulative incidence of recurrence on univariate [UHR 1.03/month (1.01-1.04); p<0.001] and multivariate [MHR 1.02 (1.00-1.03); p=0.018] modelling. Furthermore, longer wait times were associated with increased cumulative incidence of metastases on univariate [UHR 1.04/month (1.03-1.06); p<0.001] and multivariate [MHR 1.04/month (1.02-1.05); p<0.001] modelling.

Conclusions: Management delays are associated with a greater risk of recurrence and metastases. To improve patient outcomes in PCa it is imperative to reduce management delays in LDR-BT.

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MARGIN PLANNING IN PERMANENT BREAST SEED IMPLANT BRACHYTHERAPY: DOES INCORPORATING SURGICAL MARGINS MAKE A DIFFERENCE?

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Purpose: Permanent breast seed implant (PBSI) brachytherapy has the potential to benefit many women. The planning target volume (PTV) in PBSI, defined based on early experience, is a 1.25-1.5cm isotropic expansion around the seroma, cropped 0.5cm from skin and at chest wall. This margin does not consider the surgical margins of the excised tumour, as is recommended by GEC ESTRO for breast brachytherapy. This study compares PTV volumes and treatment plan parameters of the PBSI and GEC ESTRO margins.

Materials and Methods: Twenty PBSI patients with lumpectomy surgical margin documented in all directions were included in the study. PTVs were generated using two margin selections around seroma: i) PTV_{PBSI}: 1.25-1.5cm isotropic margin; ii) $PTV_{GEC\ ESTRO}$: 2cm – surgical margin in each direction. PBSI clinical plan coverage (PTV V90, V100, V150, and V200) was evaluated retrospectively for each margin. New plans were then constructed on $PTV_{GEC\ ESTRO}$ and planning parameters were compared to original treatment plans.

Results: The mean (±SD) volume of PTV_{PBSI} and $PTV_{GEC\ ESTRO}$ was 55.6±14.3cc and 36.4±15.0cc. Median (range) plan coverage on PTV_{PBSI} was: V90=97.8% (94.3-99.8%), V100=95.7% (90.6-99.3%), V150=64.6% (53.0-72.4%), V200=22.5% (19.3-25.3%), and on $PTV_{GEC\ ESTRO}$ was: V90=98.8% (90.0-100%), V100=98.0% (85.9-100%), V150=74.8% (52.0-91.8%), V200=22.5% (19.6-29.7%). New plans constructed on $PTV_{GEC\ ESTRO}$ met all the dosimetric criteria, and on average reduced the number of implanted needles by three, and seeds by 12, per patient. Skin dose (D_{1cm^2}) was also reduced to 84.0±33.5% from 95.4±29.3%.

Conclusions: $PTV_{GEC\ ESTRO}$ was smaller than PTV_{PBSI} for 18/20 patients. For most patients, applying their clinical PBSI plans to the $PTV_{GEC\ ESTRO}$ provided satisfactory V90 and V100 coverage but higher dose inhomogeneity. Planning with GEC ESTRO recommended margins showed benefits reducing total implanted seeds and skin dose in this cohort.

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ARE THE RISK GROUPS USED FOR EXTERNAL BEAM TREATMENT OF PROSTATE CANCER APPROPRIATE FOR LDR BRACHYTHERAPY?

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Purpose: Incorporation of brachytherapy (BT) into the radiation management of prostate cancer has been guided by risk stratification derived for external beam (EBRT) treatment. This raises questions about the appropriateness of these risk groups for BT of prostate cancer. We sought to derive risk groups for low dose rate (LDR) monotherapy of prostate cancer, compare them with those used for EBRT, and test for significant differences in clinical failure-free survival (CFFS) between patients in the same EBRT risk group.

Materials and Methods: A dataset was compiled from seven institutions (14,220 patients) with localized prostate cancer treated with LDR BT. Among these, the 8,344 patients treated with monotherapy were used for the analysis. Median follow-up was 5.8 years. Classification and Regression Tree analysis was carried out using CFFS (local, distant, regional or biochemical triggering salvage) as endpoint. The input variables were Gleason Score (GS), baseline PSA (PSA_0), and T-Stage. Risk at the different branches of the tree was quantified in terms of RHR=hazard of failure relative to that of the dataset as a whole. CFFS in groups with different baseline factors was compared using Kaplan-Meier analysis. Statistical analyses were carried out using STATA 14 software.

Results: In the BT dataset, 87% were treated by I-125 and 13% by Pd-103. The monotherapy BT classification tree consisted of eight branches with different RHRs, based on input variables GS, PSA_0, and T-Stage. T-Stage did not influence RHRs significantly. The eight-branch tree reduced to four branches with similar RHRs in each branch, leading to the four risk groups (Figure) as follows: *Low risk*: GS 3+3, PSA_0<6.6 (RHR=0.39, n=3180); *Favourable-intermediate risk*: GS 3+3, 6.6 ≤ PSA_0 <38.6* OR GS 3+4, PSA_0<8 (RHR=0.85-1.25, n=3486); *Unfavourable-intermediate risk*: GS 3+4, 8≤PSA_0<38.6* OR GS 4+3, PSA_0<10.3 (RHR 2.72-2.79, n=1284);

High risk: GS 4+3, 10.3 ≤ PSA_0 <88.3* OR GS 4+4 or higher, any PSA_0 (RHR 7.75-10.34, n=275). *indicates the highest PSA_0 in that branch for a given GS. There are differences in CFFS between certain risk groups for BT and the same group defined by EBRT. Among these, the biggest difference (log rank test p<0.00005) is that between the low-risk group for BT (GS 3+3, PSA_0<6.6) and the low-risk group for EBRT: GS 3+3, PSA_0<10, T-Stage T1b-T2a. Twenty-eight percent of patients classified as low-risk by EBRT risk group are reclassified as favourable-intermediate risk for BT monotherapy.

Conclusions: Choice of treatment for BT patients may be guided by BT risk groups and future analyses will clarify the impact of the addition of ADT and/or EBRT with BT on CFFS for unfavourable-intermediate-risk and high-risk prostate cancer patients.

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A SYSTEMATIC REVIEW OF INTRALUMINAL HIGH DOSE RATE BRACHYTHERAPY IN THE MANAGEMENT OF MALIGNANT BILIARY TRACT OBSTRUCTION AND CHOLANGIOCARCINOMA

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Purpose: To conduct a systematic review evaluating the impact of high dose rate (HDR) intraluminal brachytherapy (ILBT) in the management of cholangiocarcinoma on clinical outcomes and toxicities.

Materials and Methods: A review of published articles was conducted using Medline, Embase and Cochrane databases using the following search terms: "bile duct carcinoma" or "cholangiocarcinoma" or "bile duct neoplasms" in combination with "brachytherapy" or "high dose rate brachytherapy" or "HDR brachytherapy". Any additional studies identified in the references section of these articles were also screened for inclusion. Studies published in English and reporting outcomes of ³10 patients were subsequently included. Only the most recent experience was included if same patients were included in sequential publications.

Results: Seventeen studies were identified that met the inclusion criteria. Significant heterogeneity was observed in treatment regimens, which included use of surgery, external beam radiation (EBRT), and/or intra-arterial and intravenous chemotherapy in conjunction with ILBT. Among included studies, use of ILBT appeared to result in longer duration of stent patency: 10 months with ILBT compared to four to six months without ILBT. A trend was observed towards prolonged local control and improved complete (CR) and partial response (PR) rates in patients treated with ILBT with or without EBRT. Weighted mean overall survival of patients treated with ILBT alone was 11.8 months compared to 10.5 months for those that received EBRT +/- chemotherapy in addition to ILBT. The included studies reported low complication rates and toxicity related to ILBT.

Conclusions: Brachytherapy can be an effective and safe tool in the management of malignant biliary tract obstruction in combination with stenting. Both retrospective and prospective studies have suggested improved outcomes with HDR ILBT is combined with percutaneous stenting.

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DEVELOPMENT AND DESIGN OF CUSTOM 3D PRINTED CYLINDRICAL TEMPLATES FOR INTERSTITIAL GYNECOLOGICAL BRACHYTHERAPY

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Purpose: Adequately treating the range of presentations of locally recurrent endometrial/vaginal cancers is challenging with current commercial HDR brachytherapy (HDRBT) applicators. Typically, these are treated with a vaginal cylinder and/or perineal template-based interstitial needles. Cylinders are limited in the depth to which they can treat and not easily ameliorated with perineal-template-based needles when treating above the vaginal vault. To address this, we have developed a partially automated workflow for in-house design and 3D-printing of patient-specific cylindrical templates (PSCT) which allow the use of both interstitial and intracavitary catheters.

Materials and Methods: In our workflow, patients undergo a pre-operative MRI with a dummy cylinder to reflect patient anatomy at treatment. The OAR and high-risk CTV (HRCTV) are contoured, and a treatment plan is created using both interstitial and intra-applicator needles. The catheters' trajectory is then exported from the planning system (BrachyVision) to model a 3D-printable template which guides the flexible needles to the pre-planned positions. The templates are 3D-printed in PEEK. This workflow has been validated both by comparing treatment plans using PSCT to those used clinically for 5 patients and by printing the templates and comparing implanted to planned needle positions in gel phantoms.

Results: PSCT treatment plans resulted in similar HRCTV coverage with V100 values changing by 2±6% and D90 by 0±3%. OAR doses remained below clinical constraints in all cases. The bladder, rectum, sigmoid, and small bowel D2cm3 changed by -5±4%, 2±2%, -2±1E-1% and 2±4%, respectively. All changes are mean percent difference between the PSCT and clinical plans. In the gel phantoms, the average geometric variation in dwell position between planned and implanted was found to be 5±4mm.

Conclusions: PSCTs stand to be a preferable alternative to current HDRBT templates/applicators for many patients with vaginal and post-operative locally recurrent endometrial cancers. Clinically equivalent or improved treatment plans can be created compared to standard-of-care techniques. These templates have been independently validated for sterilization and three patients have been successfully treated using PSCT.

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EFFECTS OF ANDROGEN DEPRIVATION THERAPY (ADT) COMBINED WITH RADIOTHERAPY (EBRT) AND HDR-BT BOOST ON DNA REPAIR MARKERS IN PROSTATE CARCINOMA

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Purpose: The purpose of this study is to determine PCa cells response to the DNA damage (DDR) induced by HDR-BT boost with EBRT and ADT and to evaluate the impact of ADT addition.

Materials and Methods: Thirty patients with localized PCa signed an informed consent to participate in the clinical pilot study. Ten patients of them treated only with HDR-BT / EBRT and twelve patients receiving additional ADT. Eight patients were excluded from the study because their biopsy specimens did not contain representative cancer areas. The needle biopsies were taken from all patients before and after treatment. The activation of γ-H2AX double strand breaks (DSBs) marker and the expression of DNA-PKcs and RAD51 recombinase as NHEJ and HR pathway markers were analyzed by immunofluorescence and immunochemistry tests. The AR expression was also evaluated to better understand ADT mechanism action. SPSS (Statistical Package for the Social

Science) was used to compare markers expression between both groups.

Results: Our results showed an activation of γ-H2AX double strand breaks (DSBs) markers in the tissues treated with HDR-BT/ EBRT with or without ADT. We also noticed an upregulation of DNA-PKcs in the tissues treated with only radiation. However, a decrease expression of DNA-PKcs and AR was observed in the tissues receiving ADT. Whereas the RAD51 recombinase revealed cytoplasmic localization.

Conclusions: HDR-BT/ EBRT alone or combined with ADT induced DNA damage in PCa cells, especially DSBs which activated the c-NHEJ repair pathway in the tissues treated with only radiation. However, this pathway was impairing in the tissues receiving ADT because of AR suppression which allowed a downregulation of c-NHEJ repair pathway key DNA-PKcs.

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A POPULATION-BASED STUDY OF OUTCOMES IN ADJUVANT RADIOTHERAPY FOR STAGE II ENDOMETRIAL CARCINOMA

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Purpose: The objective of this study was to analyze recurrence free survival (RFS) and overall survival (OS) outcomes in FIGO Stage II endometrial cancer patients treated with adjuvant radiotherapy.

Materials and Methods: This retrospective population-based cohort study identified all Stage II (FIGO 2009) endometrioid endometrial carcinoma diagnosed between 1995 and 2019. All patients underwent surgical resection followed by adjuvant radiotherapy (RT) consisting of vaginal vault brachytherapy (VB) alone or external beam pelvic RT plus vaginal brachytherapy (EBRT+VB). Patients were excluded if they had positive washings or did not receive adjuvant RT. Data on patient, pathology and treatment characteristics was collected. Kaplan-Meier curves and Cox regression were used to assess OS and RFS, and cumulative incidence and competing risk regression was used for recurrence.

Results: One hundred twenty-one patients were included (78 VB alone and 43 EBRT+VB) with a median age of 62. Median follow up was 4.57 (VB) and 4.08 (EBRT+VB) years. Most patients had Grade 1-2 carcinoma with 14.1% and 20.9% of patients having Grade 3 disease treated with VB and EBRT+VB respectively. Lymphovascular invasion (LVSI) was present in 17.9% of VB cases versus 25.6% EBRT+VB.

There were 14 recurrences (seven vaginal vault, three pelvic, four distant) in the adjuvant VB group and seven recurrences (two vaginal vault, two pelvic, three distant) in the EBRT+VB group. Five-year OS, RFS and recurrence risk with VB were 73.1%, 65.0% and 20.3%; in the EBRT+VB group, they were 73.7%, 68.2% and 19.4%, respectively.

Only age was a statistically significant predictor for OS and RFS ($p<0.05$). LVSI was the strongest predictor for worse OS (HR, 2.97; 95% CI, 0.99-8.93) and RFS (HR, 3.26; 95% CI, 1.09-9.76). On the competing risk regression model, adjuvant RT did not predict for recurrence ($p=0.942$).

Conclusions: There was no significant difference between VB alone versus EBRT+VB for OS.

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IMMERSIVE VIRTUAL REALITY PROSTATE BRACHYTHERAPY TRAINING

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Purpose: Modern virtual reality headsets immerse users in a fully interactive 3D environment and have exploded in popularity in recent years. They have quickly gained popularity as a tool in medical education, particularly in anatomy and procedural skills training. We have developed a custom application for the Oculus Quest 2 virtual reality headset that provides an accurate simulation of the brachytherapy operating environment with guided tutorials of basic prostate brachytherapy procedures.

Materials and Methods: An Android based application for Oculus Quest 2 was developed using the Unity Development Engine. 3D assets were designed using the 3D modeling software, Blender. Interactive functionalities and tutorial sequences were coded in C#. Tutorial sequences were planned with experienced brachytherapists to ensure accuracy of the material. Haptic feedback on the Oculus Quest controllers was programed to provide physical feedback for mistakes or invalid actions.

Results: Though this application, we were able to immerse the user in a fully 3D interactive brachytherapy operation environment. Users were able to familiarize themselves with accurate 3D models of important brachytherapy components such as the stepper, template, needles and ultrasound. They were guided through procedures such as TRUS probe set-up and needle insertion via tutorials.

Conclusions: We were able to create a virtual reality application that was able to simulate the brachytherapy operating environment and provide virtual brachytherapy procedure training. The next step will be for validation in a small study with medical trainees. Eventually we plan to publish this on the Android marketplace as a freely accessible resource to medical trainees who are interested in brachytherapy.

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HYPOFRACTIONATED RADIOTHERAPY FOR BREAST CANCER: FINDINGS FROM AN INTERNATIONAL ESTRO-GIRO SURVEY

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Purpose: Hypofractionated radiotherapy (HR) for early breast cancer has been found to be equivalent to conventional fractionation (CF) in a number of large studies. More recently, accelerated HF regimens and HF in more advanced disease has been evaluated and adopted. Using data from the European Society of Radiation Oncology' (ESTRO) Global Impact of Radiotherapy in Oncology (GIRO) initiative survey on HF, this study aims to identify patterns, facilitators and barriers to uptake of breast cancer HF across World Bank income groups.

Materials and Methods: The ESTRO-GIRO initiative administered an anonymous, electronic survey to radiation oncologists from January 2018 to January 2019. Details on physician demographics, clinical practice, preferred HF regimen for specific breast cancer clinical scenarios (curative and palliative), and justifications for HF practices were collected. Curative scenarios included: node-negative (N0) following breast-conserving surgery (BCS) and mastectomy, and node-positive (N+) following BCS and mastectomy. Palliative scenarios evaluated HF for symptom control. Factors associated with HF were assessed using univariate and multivariate logistic regression models.

Results: A total of 1,434 physicians responded to the breast survey scenarios, with 1251 (87%) from high-income (HICs) and upper middle-income countries (UMICs) and 183 (13%) from lower middle-income countries (LMICs). The most common HF fraction size was between 2.5 and 2.9Gy delivered in a total of 15 fractions for curative indications; only 2% of respondents reported using a 5-fraction regimen. For palliative indications,

the most common HF fraction size was between 3Gy and 3.5Gy in 10 fractions (30%). In N0 disease following BCS, there was no significant difference in use of hypofractionation in LMICs compared to HICs and UMICs. Respondents in Africa were 71% less likely to hypofractionate (p=0.006) and those using Cobalt-60 were 45% less likely to hypofractionate (p=0.005). In the other curative scenarios, those in LMICs were more than twice as likely to hypofractionate compared to those in HICs and UMICs. There were no differences in use of HF across income groups for palliative symptom control. Published evidence was the most cited justification for HF (89%) across income groups. Lack of advanced technology was cited as a barrier by 14% in LMICs, compared to 5% in HICs and UMICs.

Conclusions: Patterns of HF for breast cancer varied across income groups for curative indications, with minimal uptake of accelerated regimens. Targeted interventions are needed to address barriers to HF and support evidence-based utilization.

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THE USE OF BOLUS IN POSTMASTECTOMY RADIATION THERAPY FOR BREAST CANCER: A SYSTEMATIC REVIEW

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Purpose: Post-mastectomy radiation therapy (PMRT), when indicated, reduces loco-regional recurrences. Bolus is thought to overcome the skin-sparing effect of - primarily - photons, providing adequate dose to superficial regions at risk of recurrence. However, limited data exists on the impact of bolus use on local recurrence (LR) rate. This systematic review summarizes the current evidence regarding the impact of bolus on LR and acute toxicity, in the setting of PMRT.

Materials and Methods: A systematic search using the string: ((radiotherapy OR "radiation therapy" OR irradiation) AND (mastectomy OR post-mastectomy)) AND (bolus OR (tissue AND compensator)) was completed. Studies with non-external beam radiation (i.e., brachytherapy) or breast-conserving surgery, as well as case reports and review articles were excluded. Data were analyzed based on LR and toxicity outcomes as well as patient and treatment characteristics (i.e., bolus and PMRT protocol). A pooled analysis of studies reporting on LR with and/or without bolus was performed.

Results: The final analysis included 27 articles. The use of bolus led to higher rates of Grade 3 radiation dermatitis (2% to 88% with bolus versus 0% to 3% without). Pooled crude LR rates from thirteen studies (n=3756) were similar with (3.5%) and without (3.6%) bolus with a median follow up of 4.2 years. In addition, three comparative studies, with no significant difference between treatment groups, showed that the use of bolus did not reduce overall LR rates (1.9% to 8.7% without bolus and 1% to 9.1% with bolus). Little is known regarding the use of bolus in the setting of immediate breast reconstruction.

Conclusions: Bolus may be indicated in cases with a high risk of LR in the skin (i.e., T4b-d, positive anterior margins), but seems not to be necessary for all. Further work is needed to define the role of bolus in PMRT.

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PREDICTIVE FACTORS OF SURVIVAL AFTER NEOADJUVANT RADIOTHERAPY AND CHEMOTHERAPY IN HIGH-RISK BREAST CANCER

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Purpose: Neoadjuvant Radiotherapy (naRT) in addition to neoadjuvant chemotherapy (nCTx) has been used for locally advanced, inoperable breast cancer or to allow breast conserving surgery (BCS). Retrospective analyses suggest that naRT+nCTx might result in an improvement in pathological complete responses (pCR) and disease-free survival. Responses achieved by nSysTx improve disease-free and overall survival (OS) and allows for the adaption of the post-neoadjuvant therapy regimes over different subgroups and chemotherapy regime. However, it is not clear whether pCR achieved with the addition of naRT has the same prognostic value.

Materials and Methods: We performed a re-analysis of 315 patients (cT1-cT4/cN0-N+) treated with naRT and nSys with longer follow-up. Patients underwent naRT to the breast and mostly to the supra-/infraclavicular lymph nodes combined with an electron or brachytherapy boost. Chemotherapy (AC, EC, CMF) was given either prior to RT and simultaneously with Mitoxantrone. We used the Cox proportional hazard regression model to estimate the effect of pCR in our cohort in different breast cancer subtypes as well as chemotherapy protocols. Clinical response markers correlating with OS were also modelled.

Results: After a median follow-up of 15.4 years 315 patients were analyzed. 10y, 15y and 20y OS was 71.8%, 64.7% and 59.5%, respectively. pCR was achieved in 29.2% and was associated with a significant improvement in OS (HR=0.52 CI-95%: 0.34-0.81; p=0.004). The prognostic impact was evident across breast cancer subtypes and chemotherapy regime. Multivariate analysis showed that age, clinical tumour stage, histological subtype and nodal status after neoadjuvant therapy are prognostic for OS. Nodal positivity either after clinical node negative or positive staging also showed an association with OS as a clinical parameters measuring the response to neoadjuvant therapy.

Conclusions: Neoadjuvant systemic therapy and radiotherapy prior to surgical resection achieves good long-term survival.

Radiotherapy-influenced pathological complete response maintains its prognostic value in breast cancer subtypes and different subgroups.

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IMPACT OF THE COVID-19 PANDEMIC ON RADIOTHERAPY PATTERNS OF PRACTICE FOR CURATIVE INTENT BREAST CANCER PATIENTS

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Purpose: In response to the COVID-19 pandemic, radiotherapy (RT) departments around the world created new policies as a means of reducing risk of exposure for patients and staff, while attempting to maintain high-quality RT. We aim to describe the impact of the pandemic on changes in breast cancer RT patterns of practice for new patient referrals at a tertiary cancer centre.

Materials and Methods: Newly diagnosed breast cancer patients referred to our department from March 17-June 30, 2020 were included. Referrals for palliative RT were excluded. Demographic characteristics, COVID-19 status (if available) and RT treatment information, including deviations from usual practice because of the pandemic, were extracted from medical records by independent reviewers, and validated by the treating radiation oncologist. Descriptive statistics were used to summarize the data. The results were compared to breast cancer patients treated from March 17-June 30, 2019.

Results: A total of 271 and 306 patients met selection criteria for the 2020 and 2019 cohorts, respectively. The majority of consultations in 2020 were virtual (96%), conducted via telephone, OTN or MS Teams, whereas in 2019 all were conducted in-person. Median age of the cohorts was similar: 58 years (range: 24-86) in 2020 and 59 years (range: 26-88) in 2019. Of those treated with adjuvant RT (n=209), 56% of patients received whole breast (WB), 36% regional nodal irradiation (RNI) and 8% partial breast (PB) RT in 2020, whereas in 2019 (n=284), 60% received WB, 31% RNI and 9% PB (Chi-squared test p=0.43). As a result of the pandemic, 78% of cases (n=211) received one or more deviations in RT practice compared to pre-pandemic institutional policies. The most common was an "altered dose/fractionation protocol" (n=197; 93%), such as use of hypofractionated RNI (2020: 97%, 74/76 cases versus 2019: 3%, 3/87 cases) or the FAST Forward regimen (2020: 43%, 57/134 WB/PB cases versus 2019: 0/197 cases). Other deviations included a delay in RT start (defined as >12-weeks post-op) noted in 11% (n=29) and omission of RT in only 8% (n=17), both were recommended when the risks associated with COVID-19 were felt to outweigh the benefit of RT. One patient had a deviation in RT as a result of testing positive for COVID-19.

Conclusions: In order to minimize hospital visits in response to the COVID-19 pandemic, a substantial proportion of breast cancer patients were seen virtually and treated with newer hypofractionated dose schedules, while total omission of adjuvant RT was infrequently observed. Continuously tracking patterns of practice provides an opportunity to evaluate the impact of the pandemic on clinical outcomes and help inform post-pandemic value-enhancing practices.

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RADIOTHERAPY FOR PATIENTS WITH METASTATIC BREAST CANCER TREATED WITH CYCLIN-DEPENDENT KINASE 4/6 INHIBITORS: A PROVINCIAL MULTI-INSTITUTIONAL REVIEW OF SAFETY AND TOXICITY

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Purpose: An increasing number of patients with metastatic breast cancer are receiving Cyclin-Dependent Kinase 4/6 Inhibitors (CDK4/6i) which might have a radiosensitizing effect. Case reports have highlighted excess toxicity when radiation is given concurrently but the incidence and severity of toxicity remain unknown in a large patient population. Our aim is to review the practice patterns and toxicity profile of radiotherapy administration in patients receiving CDK4/6i within four provincial centres.

Materials and Methods: We conducted a retrospective chart review of patients with metastatic, luminal breast cancer treated with CDK4/6i from 2015 to 2020. All patients who received radiotherapy during the course, or within one month prior to initiation, of CDK4/6i were included. Timing of radiotherapy in relation to CDK4/6i was defined as pre-CDK4/6i (radiotherapy completed prior to initiation of CDK4/6i), concurrent (when both were administered together for a day or more), and sequential treatments (CDK4/6i was stopped while radiotherapy delivered). Acute (30 days post radiotherapy), or subacute (within 180 days post radiotherapy) toxicity events were defined as Grade II (GII) non-hematological toxicity or higher as per Common Terminology Criteria for Adverse Events v4.0. We used descriptive statistics for patient, disease and treatment characteristics.

Results: Among 522 patients who received CDK4/6i, 132 patients received radiotherapy to 223 different sites. Median age was 60 (35-86) years. Radiotherapy courses involved the following sites: bone (n=178), local or regional nodes (n=28), brain and orbit (n=9), lung (n=7), and liver (n=1). One hundred twenty-six patients received Palbociclib and six received Ribociclib. Radiotherapy techniques were direct fields in 112 courses, conformal in 94 courses, and stereotactic in 17 courses. CDK4/6i was initiated within one month after radiotherapy completion in 36 patients (65 courses). Sixty patients (101 courses) had concurrent, and 36 patients (58 courses) had sequential radiotherapy treatments where CDK4/6i was stopped at a median of 12 (1-131) days prior to radiotherapy and restarted at a median of 11 (1-74) days after completion. Two GII toxicities (dysphagia and radiation recall) were reported in pre-treatment cohort after a median dose 20 (8-50) Gy. Among patients with concurrent treatment, eight acute GII toxicities (dysphagia, dermatitis, and diarrhea), three acute GIII toxicities (diarrhea, dermatitis) were observed after a median dose of 20 (6-48) Gy, with four subacute GII-III toxicities. For sequential treatment, there were four acute GII, one acute GIII after a median dose of 20 (6-50) Gy, and one subacute GIV dermatitis after SBRT to the sternum which had an overlap with previous local radiation.

Conclusions: Concurrent administration of radiotherapy with CDK4/6i might be associated with GII toxicity or more. Radiation oncologists should take CDK4/6i administration into consideration when planning radiotherapy delivery.

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IS POST-OPERATIVE RADIOTHERAPY NEEDED IN THE MANAGEMENT OF ADULT CRANIOPHARYNGIOMAS?

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Purpose: The optimal treatment of craniopharyngioma (CP) remains controversial. Although rare and benign, these tumours have a high propensity to recur locally. The choice between gross

total resection (GTR) versus subtotal resection (STR) with adjuvant or delayed radiotherapy (RT) continues to be a debatable issue. The purpose of this study is to report our experience in the treatment of adult CPs.

Materials and Methods: From 1999 to 2020, we reviewed all patients with newly diagnosed CP at our institution. Data regarding tumour characteristics, treatments, and surgery and RT-related complications were collected. The median RT prescription dose was 54Gy in conventional fractionation. Treatment outcomes were evaluated on follow-up CT or MRI imaging. Disease progression was defined as growth on imaging. Descriptive statistics were used to assess patient characteristics. The Kaplan Meier was used to assess progression free survival (PFS) and corresponding 95% confidence intervals (CI) from time since treatment initiation in the overall study population and by treatment group.

Results: Twenty-four patients with a median age of 50 years were included in this study. Two patients had papillary CP. The median follow-up was 76 months (range 9-250). Six patients had initial GTR, 11 had initial STR and seven had initial STR with adjuvant RT. The overall PFS at five years was 61% (95% CI: 43-87%). PFS at five years was 100% in the STR+RT group, 67% (95% CI: 38-100%) in GTR group, and 36% (95% CI: 15-88%) in STR group. Patients managed with surgery alone required a median of two surgeries for the management of their CP. Of the 17 patients initially treated with surgery alone, eight (47%, three GTR and five STR) required salvage RT due to disease progression at a median time of 42 months, with no further disease progression after salvage RT.

Conclusions: Our experience in the treatment of adult CP suggests that STR+RT should be considered as a viable option in the management of these tumours, and may be associated with improved PFS compared to GTR or STR alone. Larger studies would be needed to further corroborate these findings.

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UNDERSTANDING THE POTENTIAL IMPROVEMENTS IN NEUROCOGNITION AFTER RADIATION TREATMENT OF BRAIN TUMOURS WITH PROTON THERAPY

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Purpose: Radiotherapy (RT) can cause long-term changes in neurocognition that may be irreversible. Proton therapy (PT) is able to reduce the dose to normal brain structures as compared with photon RT, however, the actual clinical and neurocognitive benefit is not well known. We compared clinical photon and research proton plans to estimate the possible benefit of PT in adults with brain tumours previously treated with photon RT.

Materials and Methods: In this *in silico* dosimetry study, 11 patients who were treated with fractionated photon RT for primary CNS tumours between 2008 and 2013 underwent PT re-planning by a trained proton dosimetrist. A 3mm PTV margin was used in the photon RT plans. Proton plans were created using robustness to 3mm of motion and 3% change in the CT calibration curve. The generated proton plans were evaluated and compared to their photon counterparts and dosimetric data to organs-at-risk was collected. Statistical comparisons were done using paired t-tests. Memory outcomes (Hopkins Verbal Learning Test – Revised Delayed Recall, HVLT-R DR) were predicted using converted equivalent-doses-in-2-Gy-fractions (EQD_2) to left, right and bilateral hippocampi (HC) based on a previously published model (Ma et al., doi:10.1016/j.radonc.2017.09.035).

Results: In comparing photon versus proton plans, respectively, there was statistical trends to reduction of the mean dose to the right HC (19.7 versus 14.6Gy, p=0.051) as well as mean (14.8 versus 9.5Gy, p=0.06) and D50% (17.4 versus 12.1Gy, p=0.07) to bilateral HC. There were statistically significant reductions in the mean brain dose (16.5 versus 12.3Gy, p=0.002) and brain D50% (12.5 versus 0.3Gy p=0.01). Other structures with significantly reduced doses include the bilateral thalami (12.8 versus 4.9Gy p=0.02), left and right temporal lobes (17.2 versus 12.4Gy, p=0.006; 18.7 versus 9.6Gy, p=0.002, respectively) and right cochlea (12.3 versus 2.8Gy p=0.02). After conversion to EQD_2 and applied to a model for risk of HVLT-R DR decline, lower doses to the right HC in the proton plans are expected to result in lower risk of memory decline related to the treatment.

Conclusions: Proton therapy for adults with brain tumours reduces doses to the brain, right cochlea, bilateral thalami, right and left temporal lobes. This may result in less neurotoxic effects of radiation or decline in memory functions. These hypothesis-generating findings should be validated in prospective, longitudinal studies of neurocognition after PT.

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MULTIPLE TUMOUR BOARD REVIEW OF PATIENTS REFERRED FOR CNS IRRADIATION

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Purpose: Patients with malignant or benign central nervous system (CNS) tumours who are referred for cranial radiotherapy (RT) are evaluated for suitability of treatment modality based on clinical and tumour-related factors. To obtain multidisciplinary input, a patient's file may be reviewed prior to treatment initiation by a tumour board (TB). There are three relevant weekly TB venues for discussion at our centre: Stereotactic Radiosurgery (SRS) Intake Rounds, CNS Rounds, and Stereotactic Body Radiation Therapy (SBRT) Rounds, which are attended by similar, but not identical, clinician teams. We reviewed logistics of multiple TB review of patients referred for CNS RT.

Materials and Methods: Patients discussed at SRS Intake Rounds (November 27, 2017 – June 26, 2020) were cross referenced with those reviewed at CNS and SBRT Rounds during the same time period. Patients discussed at two different TB regarding the same lesion comprised the study cohort. Patient, logistic, tumour and treatment factors were abstracted and descriptive statistics were calculated.

Results: Of 764 patients referred to SRS Intake Rounds and 233 reviewed at SBRT rounds, 62 were discussed at both. Twenty-three were discussed within SRS and SBRT Rounds, and two at both CNS and SBRT Rounds. Of these 87, discussions of 59 (67.8%) focused on the same lesion(s)(57 brain; two spinal cord). Metastatic lesions accounted for 15.3% (9/59), while 33.9% (20/59) were meningioma, 11.9% (7/59) pituitary and 8.5% (5/59) GBM. After TB discussions, 25/59 were seen in consultation by one specialist, 29/59 by two, and 5/59 by none. For patients with metastatic lesions, the median (interquartile range) interval between rounds discussions was nine days (IQR 4-12d), median interval between consults was 14 days (IQR 13-15d), and median interval from last consult to RT start was four days (IQR 1.5-5.8d). The corresponding values for non-metastatic patients were: 17 days (IQR 9-70d), 47 days (IQR 4-86d) and 26 days (IQR 13-40 days), respectively. Final treatment decisions were external beam RT in 21/59, SRS in 18/59, surveillance in 12/59, surgery in three of 59, systemic therapy in three of 59, proton referral in one of 59 and SBRT in one of 59.

Conclusions: If a patient has a complex CNS history or lesion, discussion at more than one TB may be helpful to arrive at the

optimal recommendation; however, this must be balanced against potential delays in treatment initiation.

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ANAL CANAL CANCER TREATMENT OUTCOMES FROM A SINGLE INSTITUTION IN EIGHTEEN YEARS

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Purpose: Anal canal cancer (AC) is a rare malignancy that can carry poor prognosis. Concurrent chemotherapy and radiation have been standard treatment of locally advanced AC for many years. In the past decade, we adopted volumetric-modulated arc therapy (VMAT) in an effort to reduce radiation toxicities. This study reviews our single institution experience in 18 years to see if there is improvement in outcomes for AC patients who received this new form of radiation.

Materials and Methods: After approval from Research Ethics Board (REB), we collected consecutive data of 182 biopsy-proven AC patients who visited our regional cancer program between 2002 and 2019. We found 153 patients received radiotherapy, with the majority (131) that received concurrent chemoradiation mostly using 5-FU and mitomycin. Primary end points included overall survival (OS) and local control (LC). Kaplan-Meier curves were generated to compare OS and LC between patients that received VMAT versus conventional radiation therapy (CRT). Differences in OS and LC were further analyzed by comparing radical versus palliative radiation doses (>=45Gy versus <45Gy) and for different TNM stages. Log-rank tests were performed to determine if these differences are statistically significant.

Results: Median follow up for patients receiving any form of external beam radiation therapy (EBRT) was 130 weeks. The median age of our entire cohort was 61 years (33-98), 36% were male, 4% were HIV positive, 62% were squamous cell carcinoma, 72% were locally advanced Stage (II or III on AJCC-7), 153 (86%) received radiotherapy, including 45% VMAT and 40% CRT, 74% received 45Gy or higher dose, 49% had surgery, and 72% had chemotherapy. The three/five-year OS was 60%/47%. Within the group that had EBRT, the three/five-year OS was 55%/ 46% and the three/five-year LC was 73%/ 67%, respectively. VMAT had a higher three/five-year OS of 68%/49%, versus CRT at 54%/45%, p=0.0494 and 0.3445, respectively. Radical doses of VMAT had a trend in higher three/five/10-year OS of 62%/49%/47%, versus CRT at 55%/47%/24% (p=0.2397, p=0.4349, and p=0.0436), but the differences become non-significant when matched by Stage I to IV. The three/five-year LC was not significantly different in the two EBRT groups, 69%/60% versus 74%/71% (p=0.5893 and 0.1504). There was no treatment related death and 20% had Grade 3-4 acute toxicity. Diverting colostomy was done in 29.7% of AC patients with the majority being performed prior to EBRT as a result of obstructive symptoms. Due to the lack of consistent long-term follow up toxicity data in the electronic medical records, late toxicity analysis was not possible.

Conclusions: AC treatment outcomes in our institution are comparable to what have been reported in the literature previously. Our experience supports VMAT as standard treatment for localized AC with better or similar OS and LC compared to CRT. To reliably evaluate whether VMAT reduces radiation toxicity, large meta-analysis and prospective randomized controlled trials are needed.

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A SINGLE INSTITUTION RETROSPECTIVE STUDY OF PALLIATIVE RADIOTHERAPY FOR PANCREATIC CANCER

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Purpose: We aimed to describe the use of conventional palliative radiotherapy (RT) among patients with pancreatic cancer requiring treatment to their primary tumour.

Materials and Methods: Charts were reviewed for patients that received conventional palliative RT (≤40Gy) to an in-situ primary tumour target site from 2005-2019 inclusive. Patients were grouped according to fractionation schedules received: Group A (single fraction), Group C (≥30Gy) and Group B (all fractionation schedules between A&C). Survival was calculated from the start of patients' first RT course and in-field progression from the end of patients' first RT course.

Results: Overall cohort: n=184. Median age: 69 years (range 33-92). Gender: male n=105 (57%), female n=79 (43%). ECOG 0: n=0 (2%), ECOG 1: n=42 (23%), ECOG 2: n=63 (34%), ECOG 3: n=73 (40%), ECOG 4: n=3 (2%). ECOG status documented: n=101 (55%), ECOG status inferred: n=83 (45%). Inpatient: n=44 (24%), outpatient: n=140 (76%). Metastatic: n=115 (63%), non-metastatic: n=68 (37%), uncertain: n=1 (<1%). T2: n=6 (3%), T3: n=29 (16%), T3/4: n=21 (11%), T4: n=127 (69%). Tumour location; head: n=108 (59%), body: n=38 (21%), tail: n=25 (14%), neck: n=11 (6%), uncinate: n=2 (1%). Histology; adenocarcinoma: n=176 (96%), unknown: n=5 (3%), neuroendocrine, non-small cell carcinoma, squamous cell carcinoma: n=1 (<1%) each. No prior anti-cancer therapy: n=117 (64%). Any systemic therapy prior to RT: n=67 (36%), median time from last systemic therapy (for n=64/67 with known dates): 45 days (range 6-419). Common bile duct stent in-situ: n=90 (49%), duodenal stent in-situ: n=3 (2%). Unique dose fractionation schedules received: 21. Most common schedules: 20Gy/5: n=67 (36%), 30Gy/10: n=49 (27%), 8Gy/1: n=23 (13%), 40Gy/15: n=10 (5%), other: n= 35 (19%). Multiple fraction courses terminated early: n=14/151 (9%). Patients undergoing re-irradiation: n=2 (1%).

Group A (single fraction): n=33/184 (18%), median survival 41 days (95%CI[20,51]). Group B (all fractionation schedules between A&C) n=84/184 (46%), median survival 76 days (95%CI[55-138]). Group C (≥30Gy) n=67/184 (36%), median survival: 218 days (95%CI[129-322]. Group A in-field progression: n=1/33 (3%) at 109 days post-RT. Group B in-field progression: n=13/84 (15%) at a median of 96 days post-RT (range 19-173). Group C in-field progression: n=22/67 (33%) at a median of 97 days post-RT (range 13-475).

Conclusions: To our knowledge this is the largest report of patients with pancreatic cancer that received conventional palliative radiotherapy to their in-situ primary tumours. Most had metastatic disease, had not received prior systemic therapy and had advanced primaries in the head and body. Patients receiving higher RT doses lived longer than those receiving single fraction doses presumably due to appropriate patient selection for longer fractionation schedules rather than an effect of RT. In-field progressions were common despite short survival times post-RT.

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A CONTOURING GUIDELINE FOR THE FULL ABDOMINOPELVIC BOWEL BAG ON TREATMENT PLANNING- AND CONE BEAM CT IMAGES: FOUNDATIONAL WORK FOR ASSESSMENTS OF OBSERVER VARIABILTY, DAILY MOTION AND AUTOMATED CONTOURING

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Purpose: To establish a practical guideline with atlases for contouring the full abdominopelvic bowel bag on treatment

planning computed tomography (TPCT) and cone beam computed tomography (CBCT) images. This work aims to reduce manual contouring variability to a level that enables production of a useful ground truth while maintaining acceptable accuracy.

Materials and Methods: We reviewed existing relevant guidelines in the literature then created and refined a comprehensive definition for the bowel bag that includes all necessary structures within the full abdominopelvic compartment. TPCT and first-day CBCT images that demonstrated a range of normal anatomy and image quality were selected from seven archived patient records. A radiation oncologist with expertise in gastrointestinal radiotherapy produced serial bowel bag contours on those images to test and refine the guideline. The bowel bag definition included a list of anatomic inclusion and exclusion structures for both pelvic and upper abdominal regions. For areas where the natural anatomic bowel bag boundaries were difficult to visualize on either the TPCT or CBCT images, a set of operational definitions (ODs) was developed to approximate the natural boundaries. ODs were anchored with reference anatomical structures that were consistently visible on both TPCT and CBCT images and congruent with clinical judgements about typical anatomic structure positional variation. Fully contoured scans from three patients were converted to annotated atlases that demonstrate the full coverage of the abdominopelvic compartment with gender-specific anatomy on both TPCT and CBCT images.

Results: Existing bowel bag contouring guidelines focused chiefly on the pelvis, and none of them provided complete and practical descriptions of upper abdominal structures typically visible on TPCT and CBCT images. We defined the bowel bag as the peritoneal cavity and retroperitoneal duodenum, ascending colon and descending colon, as visualized at the time of image acquisition. Our proposed guideline is composed of a definition, a list of anatomic inclusion and exclusion structures, a set of ODs and a set of image atlases. Inconsistent visibility of the peritoneal fascial planes and insufficient image contrast between intra- and extraperitoneal structures resulted in 15 ODs. These ODs aimed to reduce contouring variability and are presented in a simple look-up table format with cross-referenced examples in the atlas images. Serial testing of the guideline showed it to permit complete bowel bag contouring on all TPCT and CBCT image sets.

Conclusions: We produced a practical guideline for contouring the full abdominopelvic bowel bag that is available with atlas images as an electronic resource. The guideline will serve as the foundation for establishing consensus ground truth contours and associated observer variability, against which daily bowel bag motion and accuracy of automated contours can be evaluated.

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SALVAGE EXTERNAL BEAM RADIOTHERAPY AFTER HIFU FAILURE IN LOCALIZED PROSTATE CANCER: A SINGLE INSTITUTION EXPERIENCE

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Purpose: Standard treatment options for localized prostate cancer include active surveillance, radical prostatectomy, or local radiotherapy. While the use of high-intensity focused ultrasound (HIFU) as a primary treatment remains investigational, it is sometimes offered to select patients. At the time of HIFU failure, there is a lack of data in salvage treatment approach. Available data includes only small retrospective series with short-term follow-up. We therefore sought to evaluate our institutional experience in a cohort of patients treated with salvage radiation therapy (SRT) after primary HIFU failure.

Materials and Methods: We conducted a retrospective analysis of patients who had local failure after HIFU. This cohort of patients received salvage external beam radiation therapy (EBRT) delivered via intensity modulated radiotherapy (IMRT). Our primary endpoint was biochemical failure-free survival (bFFS) based on the 'Phoenix' definition of PSA nadir + 2ng/mL. Secondary endpoints included metastasis-free survival (MFS) and overall survival (OS). Kaplan-Meier analysis was performed examining bFFS, MFS and OS. Genitourinary and erectile dysfunction adverse events were analyzed.

Results: From 2010 to 2018, 12 patients had local relapse post-primary HIFU and received salvage EBRT with or without androgen-deprivation therapy, 75% and 25% respectively. The mean initial PSA prior to salvage EBRT was 8.2ug/L (2.9-14.4ug/L). The median time from HIFU to salvage EBRT was 13.5 months (6-42 months). Among all men in our series, seven patients had stage migration from intermediate-risk disease prior to HIFU to high-risk disease at the time of SRT. EBRT was delivered as either conventional (76-78 Gy in 38-39 fractions, n=11) or hypofractionation (66Gy in 22 fractions, n=1). Mean PSA nadir post RT was 1.2ug/L (0.1-2.6ug/L). Acute International Prostate Symptom Score (IPSS) as well as International Index of Erectile Dysfunction (IIEF) scores were similar to baseline (p=0.5 and 0.1, respectively). Late toxicities were comparable to those reported in men receiving EBRT as their primary treatment for localized prostate cancer. At a median follow-up of 46 months, only one patient had biochemical recurrence and radiological progression. The five-year bFFS and MFS were both 83.3%. There were no deaths at the time of this analysis (OS=100%).

Conclusions: To our knowledge this is one of the largest series reporting on modern SRT post-HIFU failure. Our analysis shows that salvage EBRT is feasible, effective and carries no additional acute and delayed toxicity.

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ASSOCIATION OF BASELINE HEALTH-RELATED QUALITY OF LIFE METRICS WITH OUTCOME IN LOCALIZED PROSTATE CANCER

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Purpose: While health-related quality of life (HR-QoL) outcomes are pivotal in oncology, the prognostic significance of patient-reported HR-QoL metrics is largely undefined in localized prostate cancer (LPCa). We report the association of baseline HR-QoL metrics with overall survival (OS) and toxicity in LPCa.

Materials and Methods: This is a secondary analysis of a phase III randomized controlled study conducted in two tertiary cancer centres in a Canadian province. LPCa patients with Gleason score £7, clinical Stage T1b to T3a, and prostate-specific antigen <30ng/mL were randomized to neoadjuvant and concurrent ADT for six months starting four months before prostate RT or concurrent and adjuvant ADT for six months starting simultaneously with prostate RT. HR-QoL scores were estimated using European Organisation for Research and Treatment of Cancer QoL questionnaire. A multi-state Markov model was used to determine the association of baseline HR-QoL metrics with OS and a multilevel multivariable Cox regression to determine the association with incidence of delayed-onset grade ³3 radiotherapy-related toxicities. To adjust for multiple analyses, p-value <0.025 was considered as statistically significant. Conditional approach was used to calculate 15-year adjusted OS for patients with and without financial difficulty and

patients with and without dyspnea at baseline.

Results: Overall, 393 patients with baseline HR-QoL data were included in this analysis – 194 in the neoadjuvant arm and 199 in the adjuvant arm. Baseline financial difficulty (hazard ratio [HR]: 1.020, 95%CI:1.010-1.030, p=0.02), and dyspnea (HR: 1.020, 95%CI:1.003-1.030, p=0.01) were associated with inferior OS. Adjusted OS for patients with and without financial difficulty at baseline was 15.5% and 45.7%, respectively (p<0.01). Adjusted OS for patients with and without baseline dyspnea was 21.2% and 46.6%, respectively. Baseline dyspnea was associated with higher incidence of Grade ≥3 toxicity (HR: 1.020, 95%CI: 1.010-1.030, p=0.023).

Conclusions: In a cohort of LPCa patients treated with RT and short-term ADT, a 10-point increase in baseline financial difficulty or dyspnea was associated with a 20% increased risk of death. With each 10-point increase in baseline dyspnea, we noted an 20% increase in the associated risk of Grade ≥3 delayed-onset radiotherapy-related toxicity. These findings underscore the importance of integrating these baseline patient-reported metrics in selecting patients, making informed treatment-decisions, and optimizing overall outcome in men with localized prostate cancer.

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FOUR-YEAR PSA RESPONSE RATE AS A PREDICTIVE MEASURE IN INTERMEDIATE RISK PROSTATE CANCER TREATED WITH ABLATIVE THERAPIES: THE SPRAT ANALYSIS

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Purpose: There is a lack of early predictive measures of outcome for patients with intermediate-risk prostate cancer (PCa) treated with stereotactic body radiotherapy (SBRT). We aim to explore four-year PSA response rate (4yPSARR) as an early predictive measure.

Materials and Methods: Individual patient data from six institutions for patients with intermediate-risk PCa treated with SBRT between 2006-2016 with a four-year (42-54 months) PSA available were analyzed. Cumulative incidences of biochemical failure and metastasis were calculated using Nelson-Aalen estimates and overall survival was calculated using the Kaplan-Meier method. Biochemical failure-free survival was analyzed according to 4yPSARR with groups dichotomized based on PSA <0.4ng/mL or ≥0.4ng/mL and compared using the log-rank test. Multivariable competing risk analysis was performed to predict for biochemical failure and development of metastasis.

Results: Six-hundred thirty-seven patients were included, including 424 (67%) with favourable and 213 (33%) with unfavourable intermediate-risk disease. Median follow-up was 6.2 years (IQR 4.9-7.9). The cumulative incidence of biochemical failure and metastasis, and overall survival at six years was 7%, 0.6% and 97%, respectively. The cumulative incidence of biochemical failure at six years if 4yPSARR <0.4ng/mL was 1.7%, compared to 27% if 4yPSARR ≥0.4ng/mL (p<0.0001). On multivariable competing risk analysis, 4yPSARR was a statistically significant predictor of biochemical failure-free survival (sHR 15.3, 95% CI 7.5-31.3, p<0.001) and metastasis-free survival (sHR 31.2, 95% CI 3.1-311.6, p=0.003).

Conclusions: 4yPSARR is an encouraging early predictor of outcome in patients with intermediate-risk PCa treated with SBRT. Validation in prospective trials is warranted.

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IMPACT OF PD-L1 EXPRESSION ON ONCOLOGICAL OUTCOMES FOR PATIENTS TREATED WITH TRIMODALITY THERAPY FOR MUSCLE INVASIVE BLADDER CANCER

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Purpose: We aim to evaluate the role of PD-L1 expression in the tumour microenvironment on oncological outcomes for patients treated with trimodality therapy (TMT) for muscle-invasive bladder cancer (MIBC).

Materials and Methods: Single-centre retrospective analysis of TURBT tissues from 104 MIBC patients who underwent TMT. A tissue microarray (TMA) was designed using five 1.5mm cores per patient. All TMA slides were stained with the SP263 PD-L1 clone (Ventana Medical Systems). Two independent reviewers calculated the PD-L1 H-score for tumour and immune cells. In case of disagreement, a third senior author was involved. Logistic regression and Cox model were used to predict three-month complete response (CR) post-TMT and overall survival (OS) respectively.

Results: A total of 78 patients (75%) were male, median age was 75 (IQR: 65-80), 93 (89%) were cT2, 11 (11%) cT3. At three months, 68 (65%) had CR. Median FU was 58 months (95%CI 41-74). A total of 57 (55%) died during follow-up with a median time to death of 43 months (95%CI 20-66). On multivariate analysis, higher clinical stage (OR=0.21, 95%CI 0.06-0.78, p=0.0189) and high immune cell PD-L1 H-score (OR=1.06, 95%CI 1.01-1.11, p=0.027) were the only predictors of a CR post-TMT. On multivariate Cox regression, high immune cell PD-L1 H-score (HR=0.97, 95%CI 0.95-0.99, p=0.007) was associated with better OS, independently from ECOG status (p=0.003) and tumour stage (p=0.002). High tumour cells PD-L1 H-score was not an independent predictor for CR or OS. Similarly, when using the same definition of PD-L1 expression as the JAVELIN BLADDER 100 trial, PD-L1 positive patients were associated with better OS (HR=0.57, 95%CI 0.32-0.99, p=0.048).

Conclusions: Patients with PD-L1 positive MIBC tumours appear to have better oncological outcomes following TMT. Our results may aid in patient stratification for future clinical trial design.

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DENTITION RECEIVING >50GY IN THE TREATMENT OF HEAD AND NECK CANCER WITH VOLUMETRIC MODULATED ARC THERAPY

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Purpose: Osteoradionecrosis (ORN) of the jaw has high morbidity and lifetime risk. The dose delivered is directly correlated with the risk of developing ORN, with greater than or equal to 50Gy being an independent risk factor. Dental sextants receiving at least 50Gy were predicted at initial consultation by a radiation oncologist, and patients were then assessed by a dentist. The goal was to develop recommendations for prophylactic extraction.

Materials and Methods: Between January 1, 2018 and December 31, 2019, 327 patients with primary head and neck cancer who received at least 50Gy were selected. Consultation forms were compared to treatment plans that were reviewed in ARIA (Varian Medical Systems). Descriptive statistics were used to compare

the frequencies of teeth receiving at least 50Gy, predicted on the consultation form and in the treatment plan.

Results: Initial specificity, sensitivity, positive predictive value (PPV), and negative predictive value (NPV) was 60.74, 74.87, 83.39, and 47.87, respectively. The main factor that contributed to a sextant receiving radiation was the tumour site and type. Statistically significant results were determined by chi-squared test ($n<0.05$). Molar teeth were most likely to need pre-radiation extraction, with the TNM stage influencing different patterns of tooth involvement (unilateral versus bilateral, maxillary versus mandibular, 1st molar versus 2nd molar versus 3rd molar).

Conclusions: The relatively high sensitivity and moderate specificity are appropriate for a screening test. However, the relatively high PPV but low NPV revealed that more teeth than predicted received at least 50Gy. With the results of this study, we are developing an algorithm to predict teeth most likely to be involved in the radiation treatment plan and at greater need for prophylactic dental extraction.

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THE ROLE OF FDG-PET IN STAGING AND TREATMENT FOR STAGE III NSCLC IN ONTARIO BETWEEN 2009-2017

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Purpose: Fluoro-2-deoxyglucose positron-emission tomography (PET) is now considered standard of care in the staging evaluation for new cases of Stage III NSCLC however, there is not level 3 evidence demonstrating efficacy of PET. Using retrospective population-based data, we sought to examine the role and timing that PET scans play in influencing treatment choice, as well as survival in patients treated with chemoradiation (CRT) for Stage III NSCLC.

Materials and Methods: A retrospective cohort of patients diagnosed with Stage III NSCLC from 2009-2017 in Ontario were identified from the Institute of Clinical Evaluative Sciences (ICES). Overall survival (OS), using a landmark analysis of six months, was explored in the entire cohort (PET versus no PET) as well as in patients who received CRT for Stage III disease. Survival time was calculated using Kaplan Meier methods, logistic regression was used to evaluate type of treatment received, and Cox regression was used to evaluate factors prognostic of OS amongst patients who received CRT.

Results: A total of 13 796 cases were included in our analysis: 6536 patients underwent PET scanning prior to treatment and 7260 did not. Over time, there was a significantly increased utilization of PET from 12.4% in 2009 to 74.1% in 2017 ($p<0.001$). In regard to treatment modality, significantly more patients received curative intent therapy in the PET group including: CRT (1472 versus 939 patients; $p<0.001$), and surgery (1483 versus 734 patients; $p<0.001$). There was significantly improved OS in the whole cohort with upfront PET versus not with median OS of 17.1 (95% CI=16.3-17.8) versus 11.2 (10.6-11.9) months ($p<0.001$). In patients specifically receiving CRT, OS was similarly improved in the PET versus no PET subgroups with median OS of 21.7 (19.7-24.2) versus 18.5 (16.8-20.7) months ($p=0.004$). Examining the timing of PET scan and commencement of therapy, no significant difference was found among patients who had their scan ≤28 days prior to treatment (median OS =16 months), 29-56 days prior to treatment (17.8 months), and >56 days prior to treatment (18.6 months), ($p=0.38$); these results were similar in the CRT only subgroup. On multivariate analysis, the only factors predicting survival in the CRT group were male gender (HR 1.20; 1.08-1.33), increasing age (HR 1.07; 1.04-1.10), surgery as part of trimodality therapy (HR 0.60; 0.52-0.70), and receipt of PET prior to treatment (HR 0.83; 0.72-0.95).

Conclusions: Significant differences in treatment received and OS due to receipt of PET may be due to stage migration or unmeasured confounders. However, in a CRT subgroup, receipt of PET was associated with improved OS. Advocating for increased access to PET scans in this patient population is of utmost importance especially now with an additional survival benefit of adjuvant immunotherapy following CRT. The timing of the PET scan relative to initiating treatment did not have an obvious impact on survival, which may be reassuring for centres that may lack the capability to perform timely scans or are experiencing delays due to the COVID-19 pandemic.

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A SINGLE INSTITUTION RETROSPECTIVE STUDY OF PELVIC INSUFFICIENCY FRACTURES FOLLOWING CURATIVE-INTENT PELVIC INTENSITY-MODULATED RADIATION THERAPY FOR GYNECOLOGIC, GASTROINTESTINAL AND GENITOURINARY CANCERS

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Purpose: To determine the incidence and risk factors for Pelvic Insufficiency Fractures (PIFs) among patients receiving curative-intent pelvic Intensity-Modulated Radiation Therapy (IMRT) for gynecologic, gastrointestinal and genitourinary cancers.

Materials and Methods: This is a retrospective single institutional study. All patients with gynecologic, gastrointestinal and genitourinary cancers who received neoadjuvant, adjuvant and radical pelvic IMRT with a treatment volume that involved at least one pelvic lymph node region from 2011-2015 inclusive were included. All available computed tomography, magnetic resonance imaging and radionuclide bone scan reports for these patients were reviewed.

Results: Six hundred fifty-eight patient records were reviewed. Forty-six patients (35 women and 11 men) developed 86 PIFs corresponding to an overall incidence of 7%. The median age of patients who developed a PIF was 66.5 years (range 37-85). The median BMI was 25.2 (range 17.3-37.9). Eighty-nine percent of women were postmenopausal. Seven of 46 patients had a documented history of osteoporosis. Fifty-nine percent of affected patients had pain secondary to their PIF when it was diagnosed. The median time to developing a PIF following completion of radiotherapy was 14.5 months (range 3-53). Forty-one percent of PIFs occurred within the first year after completion of radiotherapy and 37% in the second year. Of the 86 fractures, the anatomic distribution was as follows: sacrum=62, iliac=eight, pubis=seven, acetabulum=five, lumbar=three, ischium=one. The incidence of PIFs among patients with gynecologic, gastrointestinal and genitourinary cancers was 8.8%, 10.5% and 1.35% respectively.

Conclusions: To our knowledge this is the largest single institution report of PIFs from a mixed primary cancer cohort that received curative-intent pelvic IMRT. PIFs remain a common complication for patients with gynecologic, gastrointestinal and genitourinary cancers in the era of IMRT. An analysis of clinical and dosimetric risk factors for PIFs is ongoing and will be presented.

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TREATMENT PLANNING DURING THE PANDEMIC – DID FLEXIBLE WORK ARRANGEMENTS MAKE US MORE EFFICIENT?

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Purpose: The COVID-19 pandemic has significantly altered the way we practice radiation oncology. Traditional at-work schedules were replaced with flexible work arrangements (including work from home) for many radiation oncologists (RO), planners and physicists. The current study served to determine the effect of this change on timeliness of planning task completion, and timing of work completed in a large radiation oncology department.

Materials and Methods: We collected time stamp data on tasks related to treatment planning (Target delineation, planning, plan approval, physics QA), mean time to completion, and proportion of these tasks completed outside of normal business hours (Monday to Friday, 8AM-5PM). We compared data for two nine-month periods (during COVID-19, pre-COVID-19). Descriptive statistics were used to report on our findings.

Results: The number of cases processed were similar during and pre-COVID-19 (4153 versus 4093). Tasks completed outside of normal business hours during COVID-19 slightly increased for RO targets (19.5% versus 18.3%) and RO plan approvals (12.0 versus 11.2%) but decreased for planning (7.2 versus 9.1%) and physics QA (12.7 versus 17.9%). There was significant per RO provider variation as to change in proportion of tasks done outside of regular hours (min -15%, max +19%, SD 9%).

Mean turnaround times for these tasks were not significantly different between periods; RO target delineation (2.33 versus 2.34 days), Planning (1.35 versus 1.47 days), RO plan approval (0.67 versus 0.74 days) and physics QA (0.56 versus 0.42 days).

Conclusions: According to our data, introducing flexible work arrangements during the pandemic did not appear to adversely affect the timeliness of treatment planning tasks. Our findings support the sustainability of such scheduling beyond the pandemic. However, more research is needed to understand the impact of this novel work arrangement on overall staff wellness, professional growth and team dynamics.

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PATIENT SATISFACTION WITH TELECONSULTATION DURING THE COVID-19 PANDEMIC

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Purpose: The COVID-19 pandemic has forced a paradigm shift in medicine, driving physicians to rapidly adopt remote practices to combat the spread of the virus. Radiation oncologists are no exception, but many fear that the doctor-patient relationship will suffer from such practices. We will present the results of a survey investigating the patients' level of satisfaction with teleconsultations in a radiation oncology setting.

Materials and Methods: Fifty-six patients were surveyed between June 1 and July 10, 2020. Fourteen (25%) had their consultations performed in person and 42 (75%) remotely, of which only a single patient had a video consultation. The remainder of patients had their consultations carried out telephonically. The survey was administered to patients during their treatment planning visit, and participation was on a voluntary basis.

Results: Ninety-seven percent of the respondents were either satisfied (37%) or very satisfied (60%) with their teleconsultations. Thirty-two percent would have preferred to meet their physicians in person. The number one reason for preferring remote consultations over in-person consultations was to prevent exposure to SARS-CoV-2 (75%); however, 55% of patients also stated travel difficulties as a reason for favouring teleconsultations. If this service were to be offered under normal circumstances, 51% of patients would still prefer teleconsultations. We did not identify any differences in satisfaction between remote and in-person consultations.

Conclusions: Overall, patient satisfaction of teleconsultations was high. Half of the respondents would prefer this approach to oncological care even after the pandemic is over to limit traveling. These results should reassure radiation oncologists that the care they provide remotely is appreciated by patients.

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FINANCIAL TOXICITY IS ASSOCIATED WITH HOSPITALIZATION DURING CONCURRENT RADIATION AND CHEMOTHERAPY

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Purpose: Financial toxicity (FT) is an increasingly recognized concern for cancer patients. We reviewed prospectively collected data to explore factors associated with FT among patients undergoing concurrent chemotherapy and radiation therapy (CRT) within an urban, academic radiation oncology department serving a diverse patient population.

Materials and Methods: The study population was drawn from three prospective trials at our institution of patients receiving concurrent curative-intent CRT. FT was evaluated using weekly EORTC QLQ-C30 questionnaire assessments during the concurrent CRT course. FT was rated on a 4-point Likert scale ranging from experiencing "no" FT to "very much". Patients were classified as having FT if they answered anything other than "no". Rate of change of FT per 30 days was calculated for each patient using linear regression. Those with a rate of increase ≥1 point per month were categorized as having treatment-related FT. Chi squared, t test, and logistic were used as appropriate to assess patient demographics, tumour characteristics, and hospitalization as predictors of FT.

Results: Two hundred thirty-five patients were included: 32% had head and neck cancer, 29% gastrointestinal primary, 27% lung cancer, 9% cervix cancer, and 4% glioblastoma multiforme. Thirty-four percent of the study population identified as Black or African American, and 38% identified as Hispanic. On average, patients completed QLQ-C30 5.4 times.

Before starting CRT, 52% of patients reported experiencing at least some FT. Higher T stage (p=0.003) was associated with FT before CRT on bivariate analyses. On multivariate analysis, younger age (OR=1.06, p=0.02) was associated with higher FT before CRT after adjusting for age, race, insurance, socioeconomic status, and stage.

The mean rate of change in FT was 0.23 points per month. Twenty-six percent of patients demonstrated treatment-related FT. Experiencing FT before CRT was not associated with treatment-related FT (p=0.693). Hospitalization during RT (p=0.015) and cervical cancer diagnosis (p=0.032) were associated with treatment-related FT. On multivariate analyses, hospitalization (OR 2.92, p=0.008) was associated with treatment-related FT after adjusting for age, race, insurance, and stage

Conclusions: Over half of patients reported FT prior to starting CRT. Reassuringly, most patients did not experience a significant increase in FT over the course of concurrent CRT. However, around a quarter of patients did experience treatment-related FT, which was associated with hospitalization during treatment.
The finding that patients experience FT prior to CRT start suggests that FT should be evaluated as soon as cancer is diagnosed to allow for early intervention. Further research will help define

mechanisms of FT and design interventions to improve FT and avoid hospitalizations.

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CHARACTERISTICS ASSESSMENT OF ONLINE YOUTUBE VIDEOS ON RADIOTHERAPY FOR LUNG CANCER

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Purpose: The internet has become a mainstay source of health information for cancer patients. Online patient education videos are common, however, there has been no studies examining the quality of publicly available videos on radiotherapy for lung cancer (one of the most common forms of cancer). To fill this gap in knowledge, we aim to systematically map and objectively assess videos discussing radiotherapy for lung cancer on YouTube.

Materials and Methods: The terms "radiotherapy for lung cancer," "radiation for lung cancer," "radiation therapy for lung cancer," and "radiation treatment for lung cancer" were searched on YouTube using a clear-cache browser. Results were sorted by "Relevance" and the top 50 English-language results for each search were recorded. After removing duplicates, each video was assessed for length, Video Power Index (VPI, which is the product of a video's average daily views and like: dislike ratio), source, content, comment moderation, and misinformation. Two raters were used to ensure consistency. Results were evaluated using descriptive and inferential statistics.

Results: Eighty-eight unique videos resulted from the search. The median video length was four minutes and five seconds. The average VPI was 10.9 (95% CI: 1.5-20.4) and the median number of views was 954.5. All videos were published between July 8, 2009 and November 18, 2020. Forty-four percent were published within the past two years. The majority (61%) of the videos were from the USA. Most of the videos were published by healthcare facilities (39%) and non-profit organizations (31%). Content-wise, 95% of videos contain information specific for lung cancer. Forty-six videos (52%) were targeted towards patient education. Of which, 37 covered radiotherapy for lung cancer, 12 covered side effects for radiotherapy, and 11 covered both. The other 42 videos (48%) were designed for a professional audience. SBRT/SABR was the most commonly described radiotherapy modality (42%), and the physician interview was the most common format, being used in 59% of videos. Out of the 38 videos with at least one comment, only two (5%) were moderated by the host channel. None of the videos featured misleading information.

Conclusions: This study comprehensively surveyed YouTube videos pertaining to radiotherapy for lung cancer to provide a high-level overview of the information that patients may find online. Although nearly half of the videos describe lung cancer radiotherapy for patients, only a small proportion comprehensively cover both radiotherapy and its side effects. The results of our study can help guide development of patient education tools and encourage healthcare providers to recognize limitations of online health information and proactively address patient questions regarding radiotherapy. Future research could examine videos on other lung cancer treatment options or radiotherapy for other cancers.

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A QUALITATIVE STUDY OF FACTORS TO CONSIDER IN THE INTEGRATION OF CAREGIVER-REPORTED OUTCOMES INTO PATIENT-CENTRED MODELS OF CARE

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Purpose: Eliciting patient reported outcomes (PROs) may improve quality of life and overall quality of care. Primary caregivers play important roles in the care of cancer patients and can suffer from significant burden, to the detriment of the patient. Caregiver-reported outcomes (CROs) refer to a caregiver's assessment of their own health status related to supporting a patient with cancer. Screening for caregiver burden by eliciting CROs might result in meaningful improvements similar to those associated with PROs. However, across the cancer trajectory, from diagnosis through end of life care, it is unknown how and when CRO screening should be done. Our purpose was to describe how CROs might be integrated into cancer care in a manner that best meets the needs of caregivers and patients.

Materials and Methods: Because colorectal cancer (CRC) may have a long trajectory, with caregiving being particularly demanding, we focused on caregiving of patients with CRC. Using a patient-oriented approach, we engaged patients and caregivers as research partners. Guided by a qualitative Interpretive Description approach, our team of researchers, clinicians, and patient and caregiver partners conducted and analyzed semi-structured interviews with 25 caregivers, 37 patients with CRC and 16 healthcare providers (HCPs) using inductive coding and constant comparative techniques.

Results: Patients and caregivers emphasized that HCP acknowledgement of the caregiver role and identification of supports and resources to accompany CROs are important. However, themes emerged which highlighted complexity in the consideration of how CROs might be integrated into care. Interviews revealed that caregiver roles, responsibilities and emotions change over time, driven by context and the point in the CRC trajectory. In addition, patient and caregiver participants shared contrasting perspectives about the assessment and sharing of CROs with patients. For some, transparency in the sharing of CROs with patients was considered to be essential for understanding and appreciating caregiver challenges. However, others preferred that the assessment and discussion of CROs remain private; for caregivers, this arose out of concern about burdening the patient, and, for patients, this arose out of feeling unable to hear, appreciate or attend to caregiver needs. HCPs were aware of variation in caregiver and patient preferences and described strategies for informally assessing CROs that were sensitive to these preferences.

Conclusions: For patients and caregivers, it is important for HCPs to acknowledge and support the caregiver role. The formal integration of CROs into cancer care should depend on careful consideration of factors that impact the caregiver role, including context and point in the disease trajectory, as well as caregiver and patient preferences regarding the transparency or privacy of CRO assessment and sharing of results to prevent additional burdens on caregivers and patients.

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A SINGLE INSTITUTION RETROSPECTIVE STUDY OF PALLIATIVE RADIOTHERAPY FOR BONE METASTASES: COMPARING THE FIRST SIX MONTHS OF THE 2020 COVID-19 PANDEMIC WITH THE SAME CALENDAR PERIOD DURING 2019

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Purpose: To compare treatment courses received by patients with bone metastases during the first six months of the 2020

COVID-19 pandemic with those received during the same calendar period during 2019.

Materials and Methods: Our radiotherapy information system was searched for palliative-intent treatment courses prescribed during the six-month period beginning March 14, 2020, the day that COVID-19 measures were operationalized at our institution. The same period during 2019 was similarly searched. Bone metastases cases were identified by reviewing stored images of radiotherapy plans for all treatment courses returned in the search. Descriptive statistics were used to analyze the cohorts.

Results: From 1399 courses returned in the search, 1242 were confirmed as bone metastases cases. From 2019 to 2020 the number of patients treated for bone metastases fell from 398 to 377 (5% decline) and the number of courses they received fell from 633 to 609 (4% decline). Of all courses received in 2019 and 2020 respectively, the proportion of 1-fraction courses rose from 51% (234 of 633) to 59% (359 of 609) and the proportion of 2-fraction courses rose from 3% (18 of 633) to 11% (65 of 609). The proportion of 5-fraction courses fell from 42% (266 of 633) to 28% (172 of 609) and the proportion of 6 or more fraction courses fell from 2% (10 of 633) to 0.2% (1 of 609). The three most common dose fractionation schedules received in 2019 were 8Gy/1 (49% [309 of 633]), 20Gy/5 (31% [197 of 633]) and 15Gy/5 (6% [37 of 633]), and those received in 2020 were 8Gy/1 (54% [329 of 609]), 20Gy/5 (20% [122 of 609]) and 16Gy/2 (9% [56 of 609]).

Conclusions: Compared to the same calendar period in 2019, during the first six months of the 2020 COVID-19 pandemic the number of patients treated with bone metastases and the total number of radiotherapy courses they received decreased modestly. The proportions of 1-fraction and 2-fraction courses increased noticeably, while the proportions of 5-fraction and 6 or more fraction courses decreased. An in-depth radiographic analysis is ongoing that will describe the morphologic characteristics of all treated bone metastases; data will be presented.

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EFFICIENCY OF RADIOTHERAPY DELIVERY FOR PATIENTS WITH BREAST CANCER IN A DEDICATED MULTIDISCIPLINARY PALLIATION RADIATION ONCOLOGY CLINIC

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Purpose: At least half of patients who die of cancer suffer from symptoms that adversely affect quality of life, many of which are amenable to palliative radiotherapy (PRT). In this population, urgent assessment and PRT initiation can be beneficial. At our institution, patients requiring PRT can be assessed in multiple settings, including through a dedicated multidisciplinary Palliative Radiation Oncology (PRO) clinic. We examined the logistics of PRT delivery by consultation setting.

Materials and Methods: This secondary analysis of routinely collected data examined adult female patients with breast cancer who died between April 1, 2013 and March 31, 2014, after at least one course of PRT. During this period, setting and timing of PRT consultation was at the attending physicians' discretion. Patient- and treatment-related data were abstracted including timelines of consultation, simulation (sim), treatment start and PRT completion. Descriptive statistics along with independent t-tests and Chi-square tests were calculated.

Results: Sixty-five of 121 patients had one course of PRT, 33 had two, and 23 had three or more, with on average 1.3 sites treated per course. Twenty-seven of 215 (12.5%) consults took place in the PRO clinic while 166/215 (77.2%) occurred in the on-treatment review clinic. Average interval from referral to consult, consult to sim, and sim to start for PRO visits were 4.7 days, 0 days and 1.8 days respectively; for non-PRO visits, intervals were 4.8 days (p=0.95), 1.3 days (p=0.42) and 4.8 days (p=0.008), respectively. Same day sim occurred in 100% of PRO visits versus 86.2% (162/188) of non PRO visits (p=0.052). Same day PRT start occurred in 37% of PRO visits versus 23.4% of non-PRO visits (p=0.13). 44% (11/25) of PRT courses for bone metastases prescribed after PRO visits were single fraction versus 25.6% (46/180) after non-PRO. There were no significant differences in rate of completion of prescribed PRT (100% after PRO versus 98.4% after non-PRO consults) or completion within 14 days of death (3.7% after PRO versus 5.3% after non-PRO).

Conclusions: Consultation utilizing dedicated established PRO clinic infrastructure facilitates efficacious PRT delivery.

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EVALUATION OF PALLIATIVE RADIATION QUALITY ASSURANCE PROGRAM AT A SINGLE CANADIAN CENTRE WITH ASSESSMENT OF ASSOCIATED COSTS AND COMPARISON OF TWO DIFFERENT REVIEW PROCESSES

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Purpose: Peer review of palliative intent radiation plans is an important component of quality assurance (QA) and has been made a priority by Cancer Care Ontario. The goal of this project was to better evaluate the QA process at the London Regional Cancer Program, including capturing the effects of changes to our process brought on by the COVID-19 pandemic.

Materials and Methods: This is a single-centre, quality improvement project that assessed palliative QA review at our centre between fall 2018 and fall 2020. Initially, QA involved weekly, in-person multidisciplinary rounds. However, from March to October 2020, due to COVID-19, this was changed to offline review and each plan was assigned to only a single Radiation Oncology staff for review. Characteristics of plans were captured prospectively and comments (queries and major/minor change recommendations) were tracked. Queries captured questions about the plan that were not a specific recommendation. We retrospectively abstracted the anonymized data. Descriptive statistics were generated, stratified by cohort (in-person versus offline) and compared using the chi-square test, Fisher's exact test, two-sample T-test, or Wilcoxon rank sum test as appropriate. Univariable and multivariable logistic regression were performed for any comment for all eligible variables for all patients and analyzed per plan. Cost estimates were made based on time spent reviewing plans, QA round attendance records, and the publicly available hourly wage of professionals involved.

Results: The mean ± SD age of reviewed patients was 67.1 ± 12.0 years, with no difference between in-person and offline review (p=0.784). Most common primary diagnoses were lung (32.2% in-person versus 25.6% offline), breast (13.8% versus 7.7%), prostate (10.4% versus 10.5%), colorectal (4.8% versus 10.2%), and renal cell (5.6% versus 7.7%). The most common treatment sites were brain (28.4% in-person versus 39.0% offline), spine (20.8% versus 12.3%), and non-spine bone (25.2% versus 18.9%).
Plans were also categorized by complexity (complex or simple photon plan, electron plan, or unknown). For in-person review 49.2% were complex (IMRT, VMAT, etc.) versus 47.8% simple (POP, etc.), while during the offline period complex plans were more heavily prioritized for review (95.8% complex versus 2.1% simple). Notably, plan complexity was not predictive of a comment being made (univariable analysis, odds ratio: 0.99, 95% confidence interval: 0.52-1.86, p=0.227).

The overall percentage of recorded comments per plan reviewed in-person was 2.36%. However, for in-person review, if the treating staff was present queries were addressed during rounds and not recorded. To account for this missing data and consequent underestimation, the frequency of recorded queries and the percentage of time the treating staff was present during plan review was used to extrapolate the number of queries addressed during rounds. With this, the estimated percentage of comments per plan increased to 3.19% compared to only 1.40% for offline review (p=0.097). Cost estimates for in-person review was $152 per plan reviewed and $4768 per comment made versus $105 and $7494 for offline review, respectively.

Conclusions: This study provides comparison of and cost estimates for both in-person, multidisciplinary and offline peer review. Additionally, our results suggest that review by a single, independent staff may not be sufficient and that excluding simple plans from review based solely on their lack of complexity may not be best practice.

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PALLIATIVE RADIOTHERAPY DELIVERY BY A DEDICATED MULTIDISCIPLINARY SUPPORTIVE CARE TEAM: FACILITATING EARLY INTEGRATION OF PALLIATIVE CARE FOR PATIENTS WITH BREAST CANCER

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Purpose: Despite level one evidence that early integration of specialist palliative care (SPC) improves quality of life, patients tend to access SPC late in their disease trajectory, if at all. Widespread accessibility of generalist PC competencies has been increasingly provided by dedicated palliative radiotherapy (PRT) clinics, such as the multidisciplinary Palliative Radiation Oncology (PRO) program at our institute. We evaluated the interaction between PRT delivery and need for SPC referral.

Materials and Methods: This secondary analysis of routinely collected health data examined adult female patients with breast cancer, deceased between April 1, 2013 and March 31, 2014. Alberta Cancer Registry, electronic medical records, and Palliative Care Program data were linked. Referrals for PRT and SPC were at the attending physicians' discretion. Clinical data were abstracted including intervals between PRT and SPC consultations. Summary statistics were calculated and independent samples median tests were used for comparison.

Results: Of our study cohort of 194 patients, 130 (67.0%) had at least one PRT consult, and 111 (57.2%) were assessed by SPC. First PRT and SPC consultations occurred a median of 11.5 months (interquartile range 3.6-22.1 months) and 2.8 months (IQR 0.9 -6.1 months) before death, respectively. 65.6% (42/64) of those who never had PRT received SPC involvement, versus 53.1% (69/130) of those receiving PRT consult. In the absence of previous PRT, patients had SPC consultation a median of 1.5 months prior to death (IQR 0.6-4.9 months); those who had PRT first were seen by SPC a median of 3.3 months prior (IQR 1.2-6.4 months) (p=0.08). Patients seen for PRT outside versus within the PRO clinic had SPC consultation a median of 3.2 months (IQR 1.2-6.1 months) versus 5.5 months prior to death (IQR 2.3-7.1 months), respectively (p=0.95).

Conclusions: Fewer advanced breast cancer patients who underwent PRT ultimately required SPC consultation, but those who did trend towards referral earlier in their disease course, especially if PRT delivery took place in the setting of a dedicated multidisciplinary team.

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COMPREHENSIVE ASSESSMENT OF CARE NEEDS DURING PALLIATIVE RADIOTHERAPY CONSULTATION OPTIMIZES PROVISION OF SUPPORTIVE CARE FOR PATIENTS WITH BREAST CANCER

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Purpose: Optimizing provision of supportive care in incurable cancer can be facilitated by routine screening for symptoms and functional interference to direct referrals to appropriate allied health professionals (AHP) and specialist palliative care (SPC). At the Cross Cancer Institute (CCI), patients requiring consultation for palliative radiotherapy (PRT) can be assessed in multiple settings, including through a dedicated multidisciplinary Palliative Radiation Oncology (PRO) clinic. We describe comprehensive needs assessment by setting of PRT consultation.

Materials and Methods: This secondary analysis of routinely collected data examined female patients with breast cancer who died between April 1, 2013 and March 31, 2014, and had at least one PRT consultation. Systematic screening for patient-reported symptoms was not widespread. Referrals to AHPs and SPC, and setting of PRT consultation, were at the attending physicians' discretion. Clinical data were abstracted including Karnofsky performance status (KPS) and Edmonton Symptom Assessment System (ESAS) ratings. Summary statistics were calculated and t tests of proportions compared groups.

Results: Of 130 patients, nine did not have PRT, 65 had one course, 33 had two, and 23 had three or more, with on average 1.3 sites treated per course. Twenty-eight of 224 (12.5%) total PRT consults took place in the PRO clinic. KPS was documented in 30.1% versus 89.3%; medication history in 53.6% versus 96.4%; and symptom-directed medications in 47.4% versus 96.4% of non-PRO versus PRO visits, respectively (all p<0.0001). Baseline and follow-up ESAS scores were available for 67.9% and 35.7% of PRO visits, respectively, and not available for any non-PRO visit. PRO consults had a higher proportion of subsequent AHP referrals (50% versus 8.2%; p<0.0001). Frailty score could be retrospectively derived in 89.3% of PRO versus 44.4% of non-PRO consults (p<0.0001).

Conclusions: Assessment for PRT by a dedicated multidisciplinary team utilizing patient-reported screening tools provides a comprehensive picture of overall function and symptom burden. The resulting ability to tailor supportive care referrals is essential to personalization of end-of-life care.

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METASTATIC MELANOMA REFRACTORY TO IMMUNE-CHECKPOINT INHIBITORS: CAN RADIOTHERAPY IMPROVE THE IMMUNOTHERAPY RESPONSE?

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Purpose: Immune checkpoint inhibitors have dramatically affected cancer management. Multiple trials have demonstrated improved survival and durable disease control in patients with advanced or metastatic melanoma treated with immunotherapy (IO). Combination radiotherapy (RT) with may augment the IO response via complementary immune effects. Several trials are underway investigating if this combination improves tumour response and/or survival. Here, we present our institutional experience in treating IO-resistant metastatic melanoma with RT.

Materials and Methods: This is a retrospective analysis of routinely

collected data from adult patients with melanoma who received IO treatment between august 2017 to December 2020. Patients who experienced disease progression while receiving IO proceeded to concurrent palliative radiotherapy with continuation of IO. Data extracted included immunotherapy agents and duration of treatment, radiation dose and fractionation, toxicity profile, and clinical outcomes.

Results: Thirteen patients (mean age 64 [57, 71]) were included in our cohort. Patients received treatment with CTLA-4 or PD-1IO for average of seven months and showed inadequate response or progression. Six patients received pembrolizumab (dose 2mg/kg) q3weeks, one received nivolumab (3mg/kg) q2weeks, one received ipilimumab q3weeks and five received combination ipilumumab (3mg/kg) and nivolumab (1mg/kg). Average number of cycles prior to RT was 7. RT dose ranged between 30 to 36Gy over 5-6 fractions in weekly or biweekly fractions. Post-RT assessment was between 3-5 weeks post-RT, and average follow-up at the time of data collection was 8.8 months. Tumour response assessment was per RECIST guidelines. Eight (61.5%) patients achieved partial response upon immediate follow up post-RT, one had stable disease and four progressed. On continued follow-up of initial responders, one had complete response, one showed stable disease, five (38.5%) showed continued partial response and 6 (46.1%) patients showed progression. Most patients had Grade 1 toxicities and four reported Grade 2 toxicities. No Grade 3+ toxicities occurred.

Conclusions: Our small cohort supports the concept that RT improves immunological response combined with IO in the treatment of melanoma. Treatment may be administered safely and may offer improved local control as well as survival. Larger prospective studies are needed to define the optimal role of RT with IO.

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RE-EVALUATING THE TOXICITY OF RADIOTHERAPY IN PATIENTS WITH COLLAGEN VASCULAR DISEASE: A META-ANALYSIS OF PROPENSITY SCORE STUDIES

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Purpose: Collagen vascular disease (CVD) is considered a relative contra-indication to radiotherapy. We sought to determine rates of acute and late radiotherapy-associated toxicity in patients with CVD compared to matched controls.

Materials and Methods: A systematic review was performed following PRISMA guidelines. PubMed was searched for articles from inception to February 2021. Search terms included collagen vascular disease and subtypes; radiotherapy; and cancer. Eligible studies included radiotherapy-associated toxicity rates for at least 10 patients with CVD and their matched controls. Data abstracted included number of patients with CVD; number of controls; median follow-up; treatment period; anatomic sites treated; types of CVD; acute toxicity and late toxicity. Primary endpoints were acute and late Grade 3 or higher (3+) toxicity. Random effects meta-analyses of acute and late Grade 3+ toxicity were performed using Comprehensive Meta-analysis software for patients with any CVD and their matched controls; patients with scleroderma and their matched controls; and patients with Lupus and their matched controls.

Results: The search strategy identified 3573 studies. Seventeen articles were selected for full-text review and seven were included for analysis for the primary endpoints. Patients received radiotherapy between 1964 and 2016. Three hundred fifty-three patients with CVD were matched to 617 controls, including 19 patients with scleroderma matched to 40 controls and 48 patients with Lupus matched to 82 controls. The most common sites treated were head and neck (31%), breast (29%), and pelvis (11%). Criteria for propensity score included: age, sex, cancer diagnosis, radiotherapy technique, radiotherapy dose, year of radiotherapy and anatomical site of treatment. Patients with CVD had an increased rate of acute Grade 3+ toxicity compared to controls (15% versus 9%, p<0.01, OR=2.0) and a trend toward an increased rate of late Grade 3+ toxicity (11% versus 6%, p=0.05, OR=1.7). Patients with scleroderma had an especially high acute grade 3+ toxicity rate compared to controls (25% versus 6%, p=0.03, OR=4.1). There was no significant difference in late Grade 3+ toxicity between scleroderma patients and their matched controls, and no significant difference in acute or late Grade 3+ toxicity between Lupus patients and their matched controls. Five patients with CVD and no matched controls had treatment-related death.

Conclusions: Patients with CVD have a higher rate of acute Grade 3+ radiotherapy toxicity compared to matched controls.

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QUALITY ASSURANCE OF RADIOTHERAPY DURING THE COVID-19 PANDEMIC: IMPACT ON PEER REVIEW IN 14 REGIONAL CANCER CENTRES ACROSS ONTARIO

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Purpose: Quality Assurance (QA) is an integral part of the delivery of Radiotherapy (RT). Peer review (PR) is an essential component of the QA process mandated by Cancer Care Ontario (CCO). The COVID-19 pandemic has caused significant disruptions to cancer care worldwide. We aimed to investigate PR rates across all regional cancer centres in Ontario during the pandemic.

Materials and Methods: Using a provincial database maintained by CCO, PR data regarding completed curative and palliative RT courses were reviewed from December 2014 to November 2020. Peer reviews reported completed in March 2020 onward were considered to be completed during the pandemic. The monthly PR rates of 2019 were used as a baseline comparator. Wilcoxon signed-rank test (two-tailed) was used to determine significance in PR rates and courses of RT delivered. A p-value of <0.05 was considered significant.

Results: A total of 24,936 radical courses and 18,759 palliative radiotherapy courses were completed in Ontario during the first eight months of the pandemic. We found no difference in the average number of RT courses the year prior compared to during the pandemic for radical (3117/month versus 3382/month, p=0.078) or palliative courses (2344/month versus 2227/month, p=0.195). PR rates of radical RT were significantly decreased compared to the previous 12-month time period 86.1% versus 88.5% (95% CI: 0.6%-4.6% p=0.014). Palliative RT also had a decrease in PR from 61.7% to 56.6% (95% CI:1.4%-7.2%, p=0.016). In the two immediate months following March 2020, there was a decrease of PR rates with radical RT PR rates nadiring at 83% and palliative RT nadiring a 53% PR rate, the lowest since April 2016 and January 2018 respectively. This trend quickly reversed and PR rates increased in subsequent months. Analysis by disease site indicated a significant decrease compared to the prior year in disease site-specific PR rates for radical courses within breast (87.8% versus 90.3%, p=0.16) and gynecologic (76.9% versus 84.1%, p=0.049) disease sites respectively. Lung, Head and Neck, Gastrointestinal and CNS sites had no significant differences in PR rates when compared to the preceding year.

Conclusions: Peer review rates had an initial decrease across regional cancer in both radical and palliative intent radiation. Overall, peer review rates remain modestly lower than the period immediately preceding the pandemic. All centres still maintained a high rate of PR during the initial eight months of the COVID-19 pandemic.

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THE ADOPTION OF AN ELECTRONIC PATIENT REPORTED OUTCOME SOFTWARE DURING THE COVID-19 PANDEMIC – MAINTAINING COMMUNICATION WITH OUR PATIENTS

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Purpose: Our Radiation Therapy department implemented an Electronic Patient Reported Outcomes software to facilitate patient communication of treatment related side effects and for COVID-19 screening during the pandemic. The software allowed patients to report COVID-19 and treatment related symptoms enabling radiation therapists to be more proactive in the patient's management prior to their arrival in the department.

Materials and Methods: Varian's Noona electronic patient report outcome software was deployed in radiation therapy using regularly scheduled patient questionnaires for COVID-19 screening and Edmonton Symptom Assessment Scale (ESAS) in conjunction with the symptom management aspects of the software. Radiation therapy staff were trained on the use of the software and registration process as Noona was not implemented as an integrated part of the patient's electronic medical record. Software was launched in late October and in the first 16 weeks 185 patients were registered. Inclusion criteria was for patients receiving a radical course of treatment with more than five scheduled fractions.

Results: The patient account activation rate after 16 weeks was 78%. There was a strong uptake on the completion of the scheduled questionnaires with 500 COVID-19 questionnaires completed out of the total 585 closed cases. Of the 585 closed cases, only 22 case cards were prioritized by the system as critical or high based on the symptoms reported. A subset of patients was asked to participate in one-on-one feedback sessions facilitated by the Varian implementation team and the results were very positive.

Conclusions: This software has proved to be valuable during the pandemic and in the future for patients that live in geographically isolated areas, allowing them to have reliable and consistent communication with their health care team, without having to travel to a large urban area. The rapid uptake and positive feedback from patients indicates a strong need to further expand the use of this software within our centre.

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ADVANCING RADIATION ONCOLOGY PRACTICE IN ATLANTIC CANADA (AROPAC)

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Purpose: The six radiation therapy (RT) centres in Atlantic Canada (AC) are equipped with modern technology capable of stereotactic, hypofractionated radiation techniques (SRS, SRT, SABR). However, these techniques remain significantly underutilized. A grant-funded, collaborative, regional quality improvement project was designed to support the implementation of precision RT techniques through inter-professional learning. The objective of this report is to describe the program design and early deliverables.

Materials and Methods: A team from the AC Cancer Centres and Princess Margaret Cancer Centre was convened. A needs survey of AC RT centres conducted in 2019 and updated in 2020 guided program development. Adapting to COVID-19 pandemic restrictions, a virtual CME program delivered in four phases over four months was planned. The program includes expert-led presentations and discussions, sharing of knowledge and protocols, and the development of centre-specific teams, goals, and implementation plans. A coordinated formative evaluation, using a realist evaluation approach, was designed to monitor implementation and address centre-specific and region-wide challenges to achieve accelerated implementation of precision RT techniques. Quantitative and qualitative methods will utilize the following data to be collected: use of the implementation strategies; timelines and local adoption of stereotactic RT techniques; specialists' knowledge and comfort level; specialists' satisfaction and experiences with the education received; and specialists' and decision-makers' perspectives on implementation processes, barriers, and facilitators.

Results: Phase I and II consisted of two half-day virtual meetings. One hundred twenty-six participants including radiation therapists (40), radiation oncologists (27), medical physicists (19), planners (15), trainees (10), administrators (six), nurses (four), and others (five) from all six AC RT centres. Centres with developed protocols for stereotactic RT techniques provided expert content. Virtual break-out rooms grouped centre-specific inter-disciplinary teams who determined customized goals and commenced the development of implementation plans with leadership approval. Follow-up meetings will be conducted at two and four months. Grant funding was used to support meeting organization, RTT participation, online communication platforms, and a project coordinator. The evaluation is ongoing.

Conclusions: With a collaborative expert-guided approach, evidence-based advancements in RT delivery can be accomplished in an accelerated manner on an AC regional basis despite variations in centre size and mandates. Evaluation of this process will inform on enablers to accelerate technology and improvements in the care of patients undergoing RT.

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IMPACT OF THE COVID-19 PANDEMIC ON POSTGRADUATE TRAINING IN RADIATION ONCOLOGY

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Purpose: To report the degree to which post-graduate trainees in radiation oncology perceive their education has been impacted by COVID-19.

Materials and Methods: A cross-sectional online survey was administered in June 2020 to trainee members of Canadian Association of Radiation Oncology (CARO). The 82-item survey was adapted from a similar survey administered during SARS and included the Stanford Acute Stress Reaction and Ways of Coping

Questionnaires. The survey was developed using best practices including expert review and cognitive pre-testing. Frequency statistics are reported.

Results: Thirty-four trainees (10 fellows, 24 residents) responded. Nearly half of participants indicated that the overall impact of COVID-19 on training was negative/very negative (n=15; 46%) or neutral (n=15; 46%) with a small number indicating a positive/very positive (n=3; 9%). Majority of trainees agreed/ strongly agreed with the following statements: "I had difficulty concentrating on tasks because of concerns about COVID-19" (n=17; 52%), "I had fears about contracting COVID-19" (n=17; 52%), "I had fears of family/loved ones contracting COVID-19" (n= 29; 88%), "I felt socially isolated from friends and family because of COVID-19" (n=23; 70%), "I felt safe from COVID-19 in the hospital during my clinical duties" (n=15; 46%), and "I was concerned that my personal safety was at risk if/when I was redeployed from my planned clinical duties" (n=20; 61%). The changes that had a negative/very negative impact on learning included "the impact of limited patient contact" (n=19; 58%), "the impact of virtual patient contact" (n=11; 33%), and "limitations to travel and networking" (n=31; 91%). Most reported reduced teaching from staff (n=22; 66%). Two-thirds of trainees (n=22, 67%) reported severe (>50%) reduction in ambulatory clinical activities, 16 (49%) reported a moderate (<50%) reduction in new patient consultations, while virtual follow-ups (n=25: 76%) and in-patient clinical care activities (n=12; 36%) increased. Nearly half of respondents reported no impact on contouring (n=16; 49%), on-treatment management (n=17; 52%) and tumour boards (n=14; 42%) with the majority of other respondents reporting a decrease in these activities. Electives were cancelled in province (n=10/20; 50%), out-of-province (n=16/20; 80%) and internationally (n=15/18; 83%).

Conclusions: Significant changes to radiation oncology training were wrought by the COVID-19 pandemic and roughly half of trainees perceive that these changes had a negative impact on their training. Safety concerns for self and family were significant and strategies to mitigate these concerns should be a priority.

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STRATEGIC TRAINING IN TRANSDISCIPLINARY RADIATION SCIENCE FOR THE 21ST CENTURY (STARS21): FIVE-YEAR PROSPECTIVE EVALUATION OF AN INNOVATIVE CURRICULUM IN RADIATION RESEARCH

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Purpose: STARS21 is a national research training program that has been designed to provide graduate students, postdoctoral fellows, residents, and clinical fellows the skills essential to conduct translational and transdisciplinary research in radiation medicine and aims to address an unmet need for education in this area. We hypothesize that STARS21 enriches graduate and post-graduate training to enable increased trainee proficiencies that can enhance their overall research competencies. To address this further, we developed a novel evaluation tool.

Materials and Methods: From 2015-2020, trainees completed anonymized evaluations of the STARS21 curriculum that included pre- and post-curriculum questionnaires that rated their level of proficiency on a 5-point scale (1=not at all to 5=extremely) for seven research components. Data were analyzed separately for new (n=86) and returning (n=39) trainees. Two-sided Wilcoxon signed-rank test was used to compare pre- and post-curriculum scores for each component. A p-value ≤0.05 was considered statistically significant.

Results: The overall curriculum evaluation completion rate for all trainees was 89%, and for the pre- and post-curriculum evaluations measuring perceived changes in research competencies of new and returning trainees, the completion rates were 85% and 90%, respectively. Overall, 92% of the trainees indicated that the breadth and depth of the STARS21 curriculum was just right, and that the curriculum was current and relevant. Each year, 100% of trainees indicated that they would recommend the program to their peers. Both new and returning trainees demonstrated significant increases in proficiency in all measured areas of transdisciplinary radiation medicine ($p<0.001$), interprofessional collaboration ($p<0.001$ new, $p=0.001$ returning), transdisciplinary cancer research ($p<0.001$), translational cancer research ($p<0.001$), scientific communication ($p<0.001$ new, $p=0.011$ returning), personalized medicine ($p<0.001$ new, $p=0.002$ returning), and research commercialization ($p<0.001$). The largest increases (over 1 point) in proficiency were associated with transdisciplinary radiation medicine and research commercialization for both new and returning trainees.

Conclusions: STARS21 trainees value the curriculum and program. Using a novel evaluation tool, increased perceived trainee research competencies attributable to the program were demonstrated for all new and returning trainees. This evaluation tool could be applied to other research training programs or adapted to other education settings.

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WHEN ALL LEARNERS WENT ONLINE: ENHANCING AN ONCOLOGY EDUCATION WEBSITE WITH THE ADDITION OF ASSESSMENT TO INFORM EVALUATION

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Purpose: Cancer is the leading cause of morbidity and mortality in the developed world, yet gaps are identified in all levels of medical education. Learnoncology is an online resource originally developed to function as a standardized resource for medical students based on the Canadian oncology objectives. It has since expanded to reach 169 countries and multiple health professional programs.

Learnoncology was created using Kern's framework for curriculum development. It features multiple instructional modalities including modules, YouTube videos, podcasts, and virtual patients. COVID-19 has presented an opportunity to seek novel avenues which further expand our impact. To date, evaluation of the website has focused on Kirkpatrick's Evaluation hierarchy: user satisfaction. Recently, self-assessment in the form of a quiz bank was added to evaluate knowledge acquisition. A description of assessment method use was undertaken to evaluate the website and inform future development.

Materials and Methods: Between March 15, 2020 to June 30, 2020, 31 multiple choice assessments, consisting of over 300 questions were written to complement national oncology objectives and content on Learnoncology. Quizzes were developed by medical students, reviewed by practicing oncologists and hosted on Learnoncology. Users are provided with formative feedback in the form of written explanations and asked to complete a brief evaluation. The assessment module was added to the website in July 2020.

Results: Between July 2020 and February 2021 the quizzes were attempted 2143 times. Most commonly accessed topics included common cancers such as breast and prostate, as well as fundamental principles of oncology. User feedback indicates that quizzes are overall appropriate, with some users requesting more high level content and incorporation of pictures. The most common user type is medical students at 47.7%, but there has been

an increasing number of other healthcare professionals including nurses and resident physicians. The average score across the most heavily utilized quizzes is 71.5%, indicating good knowledge acquisition of fundamental and common oncology topics.

Conclusions: As with most educational projects, Learnoncology initially focused on the development of education content with only preliminary evaluation metrics. With increasing online teaching in medical schools due to COVID-19 there is a need to continually improve online resources. The development of an assessment module will allow for enhanced evaluation of this learning tool and may inform similar projects. Further, while Learnoncology was initially created to target medical school goals and objectives, our quiz data shows that a much broader audience is utilizing the website to learn oncology principles.

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CREATION OF A NATIONAL IN-TRAINING EXAMINATION IN RADIATION ONCOLOGY – IMPACT EVALUATION

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Purpose: 2020 marked the first ever administration of a national in-training radiation oncology examination coordinated through the collaborative effort of radiation oncology program directors across Canada. The primary aim of this project is to see if a national written examination in radiation oncology is perceived as useful by residents and program directors (PDs) and if so, how can it be improved for future years.

Materials and Methods: A written examination including both short answer questions and clinical cases addressing exam subjects covered as per the Royal College was designed for radiation-oncology residents from years 2 to 5 (PGY2-5). An anonymous electronic survey was distributed to residents and program directors of the 13 programs in Canada immediately following the completion of the examination and again after examination results were released. Likert scale and free text questions regarding their preparation and overall impression of the examination were asked.

Results: Of all PGY2-5, 33 of 102 completed a pre-examination survey and nine a post one. There was a greater amount of participation from senior residents, about 60% of responses were from PGY4 and 5. Pre- and post- answers were very similar with less than 10% difference for almost all questions. Overall, more than 95% agreed that the examination should be administered again in future years and that results would highlight areas that needed reviewing prior to the Royal College examination. Of the 12 eligible PDs, nine responded to the pre-examination survey. Over 75% agreed that this standardized national exam was more efficient than the local examination and that the results would help refine teaching topics. Thirty-three percent of residents expressed a need for more radiation biology questions on the examination. Other recurrent recommendations included more physics questions, increased question clarity and consideration for transitioning to an online platform.

Conclusions: The first ever national written examination for radiation oncology residents was administered in 2020. It was viewed positively by both residents and program directors. The PD survey feedback indicated that it was an efficient method to prepare residents for their Royal College examinations. Resident feedback indicated that some subjects were lacking. This information will be used to improve the quality of the examination for future years.

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FEEDBACK DELIVERY IN AN ACADEMIC CANCER CENTRE: REFLECTIONS FROM AN R2C2-BASED MICROLEARNING COURSE

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Purpose: Feedback delivery and training have not been characterized in the context of academic cancer centres. The purpose of this study was to assess the feasibility and utility of a microlearning course based on the R2C2 (Relationship, Reaction, Content, Coaching) feedback model and to characterize multidisciplinary staff perspectives on existing feedback practices in an academic cancer centre.

Materials and Methods: A prospective longitudinal qualitative design was utilized. Five staff (two radiation oncologists, one medical oncologist, and two allied health professionals) with supervisory roles were selected by purposive sampling. The course, consisting of a web-based multimedia module, was completed by each participant. Semi-structured one-on-one interviews were conducted with each participant at four time points: pre- and immediately post-course, and at one- and three-months post course. Interviews were audiotaped and transcribed verbatim. An abductive approach informed by the R2C2 model was used to code transcripts and generate themes.

Results: All participants found the course to be time feasible and completed it in 10-20 minutes. The course was deemed useful by participants and fulfilled their self-reported needs for feedback training and normalization of feedback culture in the cancer centre. Learning retention of the R2C2 model was present in four of five participants at three-months post course. The "relationship building" and "exploring reactions" domains facilitated the most reflection during post-course interviews. Three relationship-oriented themes were identified regarding perceptions of existing feedback practices: 1) hierarchical and interdisciplinary relationships modulate feedback delivery; 2) interest in feedback delivery varies by duration of the supervisory relationship; and 3) the transactionality of supervisor-trainee relationships influences feedback delivery.

Conclusions: An R2C2-based microlearning course is time feasible and useful to the multidisciplinary study participants. The impacts of current feedback practices and R2C2 on recipient learning and clinical performance require further study.

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REMOTE CONTOURING AND VIRTUAL REVIEW DURING THE COVID-19 PANDEMIC (RECOVR-COVID19): RESULTS OF A QUALITY IMPROVEMENT INITIATIVE FOR VIRTUAL RESIDENT TRAINING IN RADIATION ONCOLOGY

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Purpose: The urgent need to minimize in-person interactions during the ongoing COVID-19 pandemic has limited trainee access to clinical learning opportunities. With ongoing utilization of virtual platforms for resident education, efforts to maximize their value are essential. Herein we describe a resident-led quality improvement initiative to optimize remote contouring and virtual contour review.

Materials and Methods: From April to June 2020, radiation oncology residents at our institution were assigned modified duties. We implemented a program to source and assign cases to residents for remote contouring, and to promote and optimize virtual contour review. Senior residents used a mentorship model to match cases with junior residents. Microsoft Teams software was used for virtual review with the supervising radiation oncologist, including direct observation with immediate feedback. Resident-perceived educational value was prospectively collected and analyzed.

Results: All nine radiation oncology residents at our institution (PGY1–5) participated in the program, and 97 cases were contoured during the evaluation period. Introduction of the RECOVR program coincided with a significant increase in mean cases contoured per week, from 5.5 to 17.3 (p=0.015), and an increased proportion of cases receiving virtual review, from 14.8% to 58.6% (p<0.001). Resident-reported overall educational value of virtual review was 4.4 ± 0.1 (mean ± standard error, 5-point Likert scale), which was comparable to in-person review (4.5 ± 0.3, p=0.993) and significantly better than no review (3.1 ± 0.4, p=0.003). The value of immediate feedback during virtual review was highly rated at 4.6 ± 0.1, similar to that of in-person review (4.5 ± 0.2, p=0.803), and significantly higher than feedback received *post hoc* (i.e. email, phone; 3.6 ± 0.2, p<0.001).

Conclusions: The implementation of a remote process for contour review led to significant increases in contouring and contour review and was rated as highly as in-person interactions. Our findings provide a data-driven rationale and framework for integrating remote contouring and virtual review into competency-based medical education. This approach may provide residents with a novel means of achieving their educational milestones and ultimately attaining the core radiation oncology competencies during the pandemic and beyond.

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DO SUSTAINABLE PALLIATIVE SINGLE FRACTION RADIOTHERAPY PRACTICES PROLIFERATE OR PERISH TWO YEARS AFTER A KNOWLEDGE TRANSLATION CAMPAIGN?

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Purpose: There is a paucity of data regarding the time-dependent effects of knowledge translation (KT) campaigns for Radiation Oncologists (ROs). In early 2017, the Canadian Partnership Against Cancer and CancerCare Manitoba undertook a comprehensive KT campaign to improve utilization of single fraction radiotherapy (SFRT) over multiple fraction radiotherapy (MFRT) for the palliative management of bone metastases. The campaign significantly increased SFRT utilization in the short-term after its completion. We assess the time trends of SFRT utilization 12-24 months removed from the KT campaign in a Canadian Provincial Cancer Program.

Materials and Methods: This retrospective, population-based cohort study identified all patients treated with palliative radiotherapy for bone metastases in Manitoba, Canada from January 1, 2018 to December 31, 2018 using provincial radiotherapy databases. Baseline characteristics were tabulated by fractionation schedule. The proportion of patients treated with SFRT in 2018 was compared to 2017 levels overall and by prescribing RO. Logistic regression analyses were performed to identify risk factors associated with MFRT.

Results: In 2018, 1,008 patients received palliative radiotherapy for bone metastasis, of which 63.3% received SFRT, a small overall increase in SFRT use over 2017 (59.1%). However, 41.1% of ROs demonstrated year-over-year decreases in SFRT utilization in 2018, indicative of a time-dependent loss of SFRT prescription habits.

Conclusions: Although SFRT use increased slightly overall in 2018, evidence of compliance fatigue was observed suggestive of a time-perishing property of radiotherapy prescription behaviours imparted to ROs by KT campaigns. These findings highlight the need for additional longitudinal reinforcement practices following KT campaigns for ROs.

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EXPLORING "WHY IT WORKED" FOR A DISTANT-LEARNING CLINICAL RESEARCH MENTORSHIP PROGRAM (CRMP) FOR RADIATION ONCOLOGY RESIDENTS IN AFRICA – A QUALITATIVE STUDY

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Purpose: Research capacity building is critical to support excellence in quality of care. This is challenging for training programs and their trainees in developing countries given the tremendous systems and health care demand. A distant-learning based collaborative program between Canadian and African training programs (CRMP) was created. The program involves partnerships with specific African residency programs in two-year cycles. Selected residents were assigned a Canadian mentor. The "supervisor, resident, mentor" triad is committed to work together for one year to support the residents in completing their research projects. In addition to a structured research methods course (12 weeks) where residents work to refine their protocol design. The mentorship continues through implementation, analysis, results dissemination and publication. Quantitative program evaluation previously published have demonstrated residents were successful in completing and disseminating their research findings at international conferences. To understand what features of the program is important for efficacy, to guide future program improvements and scale up strategies, a qualitative study was undertaken. The objectives include: 1) did the program address your objectives and if so how?; 2) what are the qualities of effective mentorship?; 3) longer term Impact; and 4) suggestions for improvement.

Materials and Methods: Since 2016, two cohorts completed the program and a third is ongoing. Residents, supervisors (African) and mentors (Canadian) from completed cohorts were invited to participate in one-on-one interviews via videoconferencing. A standardized interview guide was used, interviews transcribed verbatim and underwent thematic analysis using NVivo.

Results: Six residents, two mentors (Canada), and two program directors/supervisors (Africa) from two African radiation oncology residency programs participated in the study. It was found that the CRMP objectives of providing quality research training to build capacity was clear. Residents found the experience valuable in broadening perspectives, gaining a deeper understanding of the value of research, and supporting academic outputs. Qualities most valued in mentors include being available, displaying expertise, and fueling motivation for research. Longer term impact on the residents include generating inspiration to pursue clinical research as a career path, and to serve as mentors themselves to give back. Suggestions for improvement include building peer

capacity within each training program and across programs, providing mentorship training to faculty as well as residents, and identification of sustainable funding.

Conclusions: CRMP motivated the desire to: a) pursue clinical research as a career path; and b) serve as mentors themselves in the participants. Suggestions for improvement focus on creating teams of learners both within and across training programs, and providing mentorship training as an additional strategy towards capacity building. The latter is being evaluated in the ongoing cohort.

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A PRIORITIZATION FRAMEWORK FOR THE ANALYSIS OF NEAR MISSES IN RADIATION ONCOLOGY

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Purpose: The term near miss implies the aversion of a harm event but often there is a lack of evidence when establishing a link between a failure in process and potential harm. The focus of this study was to use reported incident data to inform a prioritization framework for the triage of near miss events in a radiation therapy program.

Materials and Methods: Actual and near miss events during the study period were categorized using thematic analysis based on incident types. Near miss were characterized based upon their potential to result in harm to the patient using the concepts of failure modes and Analytic Hierarchy Process (AHP) theory. Near miss events were assessed for occurrence, detection and the potential impact and then assigned a summative normalized score reflecting prioritization recommendations, the normalized 10- point score (NTPS).

Results: One hundred seven events were reported within the study timeframe. Sixty-five percent of event type categories (n=20) were attributed to near misses. One hundred seven total events we analyzed using the framework with a maximum NTPS of four achieved across all event types. Of the 47 actual events 100% received a NTPS of three or greater. Of the 60 near miss invents 47% received an NTPS less than or equal to one. Finally, 15% of near miss events received a NTPS of three or greater.

Conclusions: Near miss events provide a unique opportunity for learning however, can yield a great deal of data potentially limiting the resources for effective incident learning. A FMEA and AHP based prioritization framework for the triage of near miss events, including the likelihood of occurrence, probability of the event to go undetected and the potential impact if the incident did occur, allows for the optimal focus of programmatic resources in the analysis of these events.

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SPREAD OF MISINFORMATION? QUALITY OF COVID-19 RESOURCES FOR CANCER PATIENTS

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Purpose: Cancer patients are increasingly using the Internet to educate themselves about COVID-19. Recent studies have shown that cancer patients are at risk of more serious outcomes of COVID-19 compared to the general population. Some cancer treatments such as chemotherapy can impact the immune system, which may make COVID-19 infection more dangerous. This study looks to systematically examine the quality of web resources available for cancer patients about COVID-19.

Materials and Methods: The term "COVID-19 Risk and Cancer" was searched in Google and metasearch engines Yippy and Dogpile. URLs were recorded from each search and inclusion and exclusion criteria were applied. The results from the three lists were combined to come up with a final list based on overall average rank order. This list was analyzed using a previously validated structured rating tool with respect to accountability, currency, interactivity, readability, and content coverage and accuracy.

Results: Three hundred ninety-eight websites were identified prior (this includes overlap between the three search sites used), 37 websites were included for analysis. Out of 37 websites, only 43% disclosed authorship and 24% cited sources. Most websites (76%) revealed date of creation, and 32% were updated less than three months before the date of search. Sixty-eight percent of websites enabled questions to be sent to the author or webmaster regarding COVID-19 risk queries. Fifty-four percent of websites had high school readability (8.0-12.0), 43% were at university level or above, and only one website demonstrated the recommended reading level for general public (below 8.0). Topics most commonly discussed were special consideration for cancer patients in COVID-19 (84%), COVID-19 risk factors (73%), and infection prevention (62%), while topics least covered were COVID-19 incidence/prevalence (5%), prognosis (8%), and treatment (16%).

Conclusions: There is some COVID-19 in cancer risk information available online, but quality is variable. The total number of sites with relevant information related to COVID-19 and cancer was relatively low and many sites lacked markers for accountability. Some information may not be up to date and content may be difficult to comprehend. Healthcare professionals may direct cancer patients to the most reliable online resources about COVID-19 and cancer shown in this study. In addition, this may be helpful to consider when designing comprehensive web resources regarding COVID-19.

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USING PROFESSIONAL VIDEO INTERPRETATION TO ENHANCE PATIENT EDUCATION FOR RADIATION THERAPY PATIENTS WITH LIMITED ENGLISH PROFICIENCY

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Purpose: The purpose of patient education is to maintain or improve health throughout the cancer care journey, from diagnosis to treatment and beyond. COVID-19 has undeniably created a shift in the delivery of cancer care education with the transition to virtual care and enforcement of visitor restrictions. This has hindered equity and inclusion for patients with limited English proficiency (LEP) as they rely heavily on family members to be ad hoc interpreters. Language barriers are linked to less health education, lower interpersonal care and lower patient satisfaction. At the time of the project, professional over-the phone interpreters were used infrequently. The purpose of this project was to investigate alternate methods to enhance patient education for patients with LEP.

Materials and Methods: A needs assessment was completed by surveying staff about their perspectives on current LEP education and interpreter use in the department, and patients to determine their comfort in communicating with radiation therapists and their preferred interpretation methods. After assessing the results of the needs assessment and examining interpretation options, professional video interpretation was implemented in February 2020. Interpreter usage has been tracked and post-implementation evaluation conducted with staff and patients.

Results: According to the staff survey (n=69), professional over-the-phone interpreters were used least at 8% compared to other methods due to inconvenience and time constraints. Although family members (59%) and bilingual staff (62%) are most commonly used for convenience, decreased accuracy and workflow disruption were significant concerns. In addition, of the 34 staff that are fluent in a second language, only 6% stated that they were 'very comfortable' in interpreting medical conversations. Patient surveys (n=12) indicated that 67% of LEP patients were not aware that the hospital offered free interpretation services. When asked if they were comfortable asking questions or discussing side effects with their therapists, only 36% and 40% were very comfortable, respectively. When asked which interpretation method they would most prefer for daily interactions, patients and staff showed similar results with bilingual staff members as most preferred (35%), professional face-to-face interpreters (30%), family member or friend (22%) and professional over-the-phone interpreters (13%). With the implementation of professional video interpretation, professional interpreter usage increased two-fold after COVID-19 visitor restrictions were enforced. Positive feedback has been received by both patients and staff.

Conclusions: The needs assessment analysis revealed that ad hoc interpretation was used most frequently and preferred by both patients and staff. However, challenges can arise if family members also have LEP or are unable to accompany the patient, and if staff do not speak the patient's language. During COVID-19, the implementation of an institutional live-video interpretation service showed a two-fold usage increase since visitor restrictions were introduced. LEP patients have been more comfortable asking questions and staff have complimented the convenience and accessibility of the video interpreters. Video interpretation is a convenient tool that allows radiation oncology staff to use professional interpreters to communicate with patients virtually face-to-face and accurately provide education in their preferred language.

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AN INTERACTIVE SMARTPHONE APPLICATION FOR MEDICAL STUDENT ORIENTATION AND LEARNING IN RADIATION ONCOLOGY: "THE RAD ONC HANDBOOK"

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Purpose: Despite the importance of radiation oncology in the care of cancer patients, medical school curricula offer very limited exposure to this small and highly specialized field. Most medical students will not undertake radiation oncology electives and rely on brief medical school lectures and clinical encounters as a foundation for radiation oncology knowledge in their careers. Radiation oncology texts and literature are often technically advanced, and can be inaccessible to students, and there is a dearth of clinically relevant introductory materials for future physicians. We developed a free, interactive smartphone application to prime medical students on the basics of radiation oncology to address this resource gap.

Materials and Methods: We created and implemented an Apple iOS smartphone application to orient junior medical students to radiation oncology. The application is advertised to students during an introductory radiation oncology lecture. The beta version is made free for download via the TestFlight application (https://testflight.apple.com/join/4A6qXjq2). The application incorporates introductory topics targeted to medical students on radiation physics, radiobiology, indications for radiation treatment, treatment side effects, clinical workflow, and the multidisciplinary nature of radiation therapy. Written content and podcast style audio lectures are available for different learning approaches along with interactive features including quizzes and clinical cases to facilitate knowledge transfer. The platform offers learners the ability to track their knowledge acquisition as they complete the different modules.

Results: In the initial phase of testing and development, qualitative evaluation of the application is assessed through in-app feedback and surveys. Quantitative evaluation is ongoing and is facilitated through a five-item questionnaire using a Likert scale evaluating app design, ease of use, relevance, learning, and perception of knowledge acquisition. At the time of submission, we have 10 survey participants, however, over 30 learners have downloaded the application and we expect approximately 100 users and 30-40 survey participants as the application will be presented to more groups of students over the following months. Currently, over 70% of survey participants have selected "agree" or "strongly agree" to all questionnaire items.

Conclusions: This free smartphone application designed specifically for medical students provides an easily accessible resource for self-directed learning and orientation to an underrepresented field in the undergraduate medical curricula. User feedback has been very positive. As the current trend for web-based learning continues, having efficient, diverse, and interactive learning tools addressing the variety of needs of individual learners is important to fill the gap in radiation oncology for undergraduate medical education.

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NAVIGATING RADIATION THERAPY DURING COVID-19 USING YOUTUBE AS A SOURCE OF INFORMATION

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Purpose: The internet is increasingly becoming an important source of health care information for patients. YouTube videos are accessible to a wide audience, being both audio and visual sources of information. The content and quality of information being disseminated to cancer patients in regards to radiation therapy and COVID-19 has not been investigated. This study aims to characterize and assess YouTube videos related to radiation therapy in the COVID-19 pandemic.

Materials and Methods: A YouTube search using the terms "Radiation therapy COVID-19", "Radiation therapy coronavirus", "Radiotherapy COVID-19", and "Radiotherapy coronavirus" was completed using a clear-cache web browser. The top 50 videos sorted by "Relevance" were collected from each search. After removing duplicates and non-English videos, each video was assessed for general parameters of the videos, characteristics of the publishing channel, and content of the video. Two raters assessed 10 randomly selected videos to ensure interrater reliability. The data were analyzed with both descriptive and inferential statistics.

Results: One hundred eleven unique English videos resulted from the four searches. The videos were published between January 23, 2020, and January 11, 2021, with the exception of one outlying video published on August 10, 2012. 97.3% of videos were published in the last year. The median video length was six minutes and 54 seconds, and the median number of views was 570. The majority of videos were from the United States (56%). The majority of videos were published by a commercial channel (31%), non-profit organization (26%), or health care facility (24%). Sixty-seven percent of videos had no mention of either radiotherapy or cancer, and 5% of videos had misleading information. The major themes were changes to radiation including hypofractionation and delays to treatment, safety of radiation

such as using telemedicine and safety measures for in-person visits, and cancer-specific information all in the context of the COVID-19 pandemic.

Conclusions: This study provided an overview of the current YouTube videos that patients may access about radiation therapy during COVID-19. The results indicate that this information is not highly relevant and can be misleading. Cancer patients are currently navigating both diagnosis and management and COVID-19. The results of this study highlight the need for improved educational resources for patients and the need for healthcare providers to address patients' questions directly.

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RADIATION ONCOLOGIST CONSULTATIONS PRIOR TO RADICAL PROSTATECTOMY IN ONTARIO: DISPARITIES AND IMPLICATIONS FOR HEALTH HUMAN RESOURCE PLANNING

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Purpose: Men with localized prostate cancer have many options for initial definitive treatment. In 2015, Cancer Care Ontario Quality Based Procedures (QBP) recommended that men undergoing radical prostatectomy (RP) be seen by a radiation oncologist (RO) or discussed at a multidisciplinary case conference (MCC) prior to surgery. An a-priori target rate of 76% was set by QBP, but to our knowledge, has not been reported upon to date. Our objective was to use population-based data to explore factors associated with not receiving RO consult/MCC prior to RP.

Materials and Methods: Men with localized prostate cancer diagnosed and treated in Ontario with RP between 2007 and 2017 were identified using administrative data from the Institute for Clinical Evaluative Sciences. Physician billing data was utilized to identify patients who received RO consult/MCC prior to RP. Trends were evaluated using the Cochran-Armitage test. Multivariable logistic regression was used to identify patient and provider factors predictive of RO/MCC prior to RP.

Results: 31,467 men with localized prostate cancer underwent RP between 2007 and 2017. Prior to RP, 29.3% of men were seen by RO, 1.0% underwent MCC, and 1.6% had both. RO consult/MCC prior to RP increased from 18.0% in 2007 to 47.8% in 2017 ($p<0.001$). On multivariable analysis, the Odds Ratio (OR) of RO consult/MCC prior to RP between the lowest and highest geographic regions (LHINs) was 8.79 (95% CI 6.83–11.32, $p<0.001$). RO consult/MCC was less likely to occur for patients living further from the nearest cancer centre (OR 0.74 per 50km, 95% CI 0.70–0.77, $p<0.001$) and more likely to occur for men residing in the highest versus lowest income quintile regions (OR 1.42, 95% CI 1.30–1.55, $p<0.001$). Men with NCCN Low (OR 1.31, 95% CI 1.16–1.47, $p<0.001$), High (OR 1.20, 95% CI 1.09–1.31, $p<0.001$) or Very High (OR 1.24, 95% CI 1.11–1.30, $p<0.001$) risk disease were more likely to receive RO consult/MCC compared to those with favourable-intermediate risk disease. Of the 128 urologists who performed at least 10 RP between 2016–2017, RO referral/MCC rate ranged from 0% to 100%, with 31 urologists (24.2%) having ≥76% of their patients seen prior to RP. To meet QBP targets in 2017, an additional 701 men would have needed RO consult/MCC. If all were seen by RO, approximately 2.4 additional full time equivalent RO positions would be needed.

Conclusions: Despite increasing rates of utilization, a large proportion of men are not seen by RO or MCC prior to RP in Ontario. While the largest factors predicting RO consult/MCC discussion appear to be geographic and which urologist performs the RP, these factors are closely intertwined. In addition, these factors may be related to RO availability and radiation system capacity, which would need to be addressed to meet patient demand should QBP consultation rates be mandated to reduce disparities in pre-RP consultation practices.

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PREDICTING ONCOLOGIC SURVIVAL OUTCOMES USING MACHINE LEARNING AND LARGE-SCALE REGISTRY DATA – THE BC CANCER REGISTRY EXPERIENCE

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Purpose: Machine learning (ML) is a rapidly evolving field of data modeling capable of leveraging complex inputs to generate survival prediction. The increasing adoption of electronic health record enables ML prediction of patient survival using real-world data (RWD). We explore the use of large-scale cancer registry data to train two ML algorithms and the gold standard Cox Proportional Hazards Model (CPH) to predict survival outcomes in patients with head and neck, prostate and lung cancer.

Materials and Methods: Following research ethics approval, patients with SCC head and neck (910), adenocarcinoma of the prostate post radical prostatectomy (2411) and lung cancer patients with metastatic disease to brain (1616) were included. Features employed were age at diagnosis, sex, tumour site, histology as well as laterality, tumour grouping, clinical stage and performance status when available. Two ML models (SVM and RF) and the gold standard statistical CPH model were employed after randomly splitting all patient data into a training and testing dataset in an 8:2 ratio. Concordance index (CI) was used to evaluate the performance of survival prediction.

Results: For the head and neck cohort, CI of the training and test dataset, respectively, was as follows COX: (0.73, 0.68), SVM (0.73, 0.68), RF (0.74, 0.68) with clinical stage as the top-weighted feature. For the prostate cancer cohort CI was COX (0.61, 0.60), SVM (0.61, 0.60) and RF (0.71, 0.63) with the top weighted feature total radiation dose. However, the data was mostly censored and PSA as an endpoint was not captured in the registry limiting modelling effectiveness. In the lung brain metastasis cohort CI was COX (0.66, 0.66), SVM (0.66, 0.66), RF (0.67, 0.64) with performance status as the top-weighted feature.

Conclusions: ML methods performed on par or better than CPH. These methods are however constrained by the availability and accuracy of recorded variables (e.g. PSA, performance status, clinical staging). This analysis emphasizes the need for robust large scale registry capture to allow for superior computationally driven survival outcome modeling and improvements in patient outcomes based on RWD.

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CHANGES IN THE INCIDENCE OF CERVICAL SQUAMOUS CARCINOMA/CARCINOMA IN SITU IN ONTARIO FOLLOWING THE APPROVAL OF A HUMAN PAPILLOMAVIRUS VACCINE

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Purpose: Multivalent human papillomavirus (HPV) vaccines hold significant promise in reducing the overall burden of cervical dysplasia and cancer in the population as a whole. The purpose of this study was to investigate changes in the incidence of cervical squamous cell carcinoma (SCC) and carcinoma in situ (CIS) in Ontario following the approval of a human papillomavirus (HPV) vaccine.

Materials and Methods: The first multivalent HPV vaccine was approved in Canada in 2006 for females aged 9 to 26. Ontario introduced an elective HPV vaccination program for grade 7 girls (aged 12-13) in 2007 and the earliest year that this cohort would have begun cervical cancer screening was 2015 (aged 21). Age-adjusted incidence rates of cervical SCC and CIS in Ontario between 2006 and 2016 were obtained from the population-level Ontario Cancer Registry using the SEER*Stat platform. Differences in incidence rates were examined with rate ratios and the time trends in incidence rates were examined with the Joinpoint Regression Program. The primary population was individuals aged 20-24 at the time of SCC/CIS diagnosis, reflecting those who would have been eligible for the grade 7 vaccination program. To estimate the impact of a change in the cervical screening guidelines in Ontario in 2011 that might have decreased detection rates, the incidence rates of individuals aged 25-34 and >34 were also obtained, representing those who would have had elective non-school based vaccine access since 2006 and those who would not have had significant vaccine access since 2006, respectively. Results were calculated for the entire province and also stratified by urban (<10% rural population) and rural census divisions. A p-value threshold of 0.05 was used for statistical significance. All incidence rates were per 100,000.

Results: The age-adjusted incidence rate of cervical SCC/CIS among those aged 20-24 at the time of diagnosis was 90.4 in 2006, versus 85.6 in 2015 (p=0.29) and 80.9 in 2016 (p=0.03). The decrease in incidence rate was mainly observed in urban areas (p=0.03 for urban and p=0.71 for rural). The incidence rate rose significantly between 2006 and 2010 (+11.3%/year, p<0.001), followed by a significant decrease between 2010 and 2016 (-8.0%/year, p<0.001). Among those aged 25-34, the incidence rate was 116.5 in 2006, versus 150.2 in 2015 (p<0.001) and 155.0 in 2016 (p<0.001), with no difference in trend between urban/rural regions. There was a brief trend towards decreasing incidence between 2011 and 2014, but incidence rates rebounded in 2015 and 2016 in this age group. For those aged >34, the incidence rate was 24.3 in 2006, versus 40.4 in 2015 (p<0.001) and 41.4 in 2016 (p<0.001), with no difference between urban/rural regions. Similarly, no significant downward trend in incidence rate was observed in this age group.

Conclusions: A significant reduction in cervical SCC/CIS incidence rates was found in 2016 compared to 2006 among Ontarians aged 20-24 residing in urban areas, following a downward trend since 2010. This is likely not solely explainable by a change in cervical screening guidelines due to the lack of such a trend in other age groups. This result should be interpreted in the context of relatively modest HPV vaccine uptake among the general eligible population (~60%). This hypothesis-generating study is the first to explore the potential whole population-level impact of the introduction of an HPV vaccine in a Canadian province.

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SURVIVAL OUTCOMES IN METASTATIC EWING SARCOMA TREATED WTIH WHOLE LUNG RADIATION

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Purpose: There is limited research on outcomes of patients with metastatic Ewing sarcoma limited to pulmonary metastases who receive whole lung radiotherapy (WLRT). This study evaluates WLRT use and survival outcomes in patients with metastatic Ewing sarcoma treated with versus without WLRT.

Materials and Methods: Patients of all ages with metastatic Ewing sarcoma restricted to lung referred to BC Cancer from 1995 to 2017 were identified from the Sarcoma Outcomes Unit. Patient demographics, tumour and treatment characteristics were compared between cohorts treated with versus without WLRT. Five-year progression-free survival (PFS) and overall survival (OS) were evaluated using Kaplan-Meier (KM) estimates and compared between treatment groups with log-rank tests.

Results: Thirty patients comprised the study cohort (median follow-up time 6.8 years). Fifteen (50%) patients received WLRT (median 1500 cGy in 10 fractions). Chemotherapy was used in 97% of patients and surgery for lung metastases in 40% of patients. There were similar rates of lung surgery in the WLRT versus no WLRT groups (both 40%). Overall, the median age was 22 years (range 4-86), 60% were female, primary disease site was 27% axial skeleton, 53% appendicular skeleton, 20% visceral, 85% had >1 lung metastases, and 60% had bilateral disease. The mean size of the largest lung metastasis in the WLRT cohort was 1cm (range 0.3-1.8cm), compared to 2.4cm (range 0.5-6.7cm) in the no WLRT cohort, (p=0.05). Demographics and tumour characteristics were otherwise similar between the two treatment groups (all p>0.05). Among patients who received WLRT, 7% had complete response, 53% partial response and 40% disease progression. Five-year PFS was 86% versus 59% (p=0.33) and OS 78% versus 54% (p=0.24) respectively for patients treated with WLRT versus no WLRT. Five-year PFS outcomes were higher in patients with appendicular skeletal compared to axial skeletal and visceral primary sites (87.5% versus 58% versus 50%, respectively, p=0.02) and size of largest lung metastasis <2 cm (80% versus 25%, p=0.04).

Conclusions: Patients treated with WLRT had smaller volume lung disease. While complete response rate to WLRT was low, approximately half of patients who received WLRT had partial response. Trends for improved PFS and OS at five years were observed among patients who received WLRT but these were not statistically significant.

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ILLUMINATING THE GAP: DEFINING CHILDCARE NEEDS FOR CANCER PATIENTS AND THEIR FAMILIES

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Purpose: One in two Canadians will be diagnosed with cancer in their lifetime. With a growing proportion of patients under the age of 60, it is estimated that upwards of 25% of cancer patients are managing the demands of childbearing and parenting alongside their diagnosis. There is a paucity of research detailing how parents with cancer balance their needs with the needs of their children. This study aims to more completely define the childcare needs and perspectives of cancer patients with dependent children.

Materials and Methods: Between December 2020 and February 2021, cancer patients at one major Canadian Cancer Centre, who identified as primary caregiver to at least 1 dependent (<18 years of age) were invited to partake in a survey study. The survey was developed through consultation with a multidisciplinary team and best survey practices, and consisted of 34 closed and open-ended questions designed to assess childcare needs and the experiences of cancer patients with dependent children. Specific

questions were also designed to assess the impact of COVID-19 on childcare needs. Eligible participants were identified by a research assistant and presented the opportunity to complete an electronic or paper-based survey. This study was approved by the local Research Ethics Board.

Results: As of February 2021, 42 patients had been contacted and 29 had completed the survey in full (69%) Participants were an average age of 44.7 years ± 4.8 years and 97% female (28/29). Twenty-two participants (76%) reported diagnoses of breast cancer. Participants reported caring for two (18/29), one (10/29), or three (1/29) children. The average age of participants' children was 8.4 years, and ranged from 8 months to 18 years. Fourteen participants (48%) indicated having to reschedule appointments due to issues with childcare (nine of 14 rescheduling 1-3 appt.; 4/14, 4-6 appt.; one of 14, 10+ appt.). Additionally, 11 participants (38%) reported bringing their child or children to their appointments as a solution for issues with childcare (seven of 11 for 1-3 appt.; three of 11, 4-6 appt.; one of 11, 10+ appt.). Fourteen of 26 respondents (54%) indicated that balancing childcare throughout their cancer journey has had a moderate (eight of 26) or extreme (six of 26) impact on their stress levels. Sixty-one percent (17/28) reported that the COVID-19 Pandemic has impacted their childcare needs and impacted their stress levels moderately (10/17) or extremely (three of 17). Seventy-eight percent (21/27) reported that a flexible childcare service would allow them to more regularly attend their appointments. The preferred delivery of such a program was on-site (hospital or cancer centre) (13/20, 65%), followed by in-home (seven of 20, 35%). Narrative analysis noted themes of increased stress and childcare responsibilities associated with the COVID-19 Pandemic and reduction of childcare resources and support.

Conclusions: These preliminary results indicate that childcare issues are broadly impactful for parents battling cancer. The lack of supportive childcare negatively impacts the emotional psychological well-being of patients and their children, as well as impacts system efficiency and treatment compliance. Survey accrual is continuing and complete findings will aid in defining the childcare needs and perspectives of parents with cancer, as well as highlight potential solutions to support these individuals.

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PATIENT REPORTED OUTCOMES IN BREAST CANCER: DEVELOPMENT AND VALIDATION OF A NOVEL AND CLINICALLY USEFUL QUESTIONNAIRE

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Purpose: Despite the existence of multiple PRO questionnaires for breast cancer patients, none contain the necessary elements or validation in patients undergoing radiotherapy. Therefore, we created a clinically relevant PRO to be used for breast cancer patients during curative intent radiotherapy to assess health related quality of life challenges and symptoms.

Materials and Methods: A multi-phased approach per the European Organization for Research and Therapy of Cancer (EORTC) Quality of Life Group, Guidelines for Developing Questionnaire Modules was used. A conceptual framework was derived from current literature and reviewed and edited by healthcare professionals (HCP) and by breast cancer patients in focus groups. Next, items were reworded and re-grouped according to the conceptual framework and a draft questionnaire was created. The draft questionnaire was revised (content and language) through a second set of patient focus groups. Further feedback and edits from HCP and individual patients was used to create the final version.

Results: An initial conceptual framework containing 218 items was consolidated to 194 items. Informed by three focus groups with 16 patients (aged 30-78 years), the conceptual framework was refined and was the basis of the draft questionnaire. The questionnaire included three domains (Physical Symptoms, Quality of Life, and Education and Support) and 36 items. Based on the second set of 3 focus groups (16 patients, aged 39-88 years), items were further reduced to a total of 27 and item wording was modified. HCP (n=17) and patients (n=3) reviewed the 27-item questionnaire and the majority scored the items as "quite or highly relevant." Patients did not recommend deletion of any of the items. HCP recommended deletion of a few items as they were felt to be redundant or not useful. The final questionnaire contained 22 items.

Conclusions: A PRO was created that is clinically relevant to breast cancer patients undergoing curative intent radiotherapy. Validation with a larger cohort of patients is underway.

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PREVALENCE OF PALLIATIVE RADIOTHERAPY ABSTRACTS PRESENTED AT ANNUAL SCIENTIFIC MEETINGS OF THE CANADIAN ASSOCIATION OF RADIATION ONCOLOGY: 2009-2020

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Purpose: Approximately half of all radiotherapy is delivered with palliative intent. Clinical research in palliative radiotherapy (PRT) aims to manage symptoms, improve quality of life (QoL), evaluate supportive care interventions, and determine optimal dose-fractionation schedules, amongst other goals. The Canadian Association of Radiation Oncology (CARO) Annual Scientific Meeting (ASM) provides opportunities to discuss new developments and disseminate knowledge. Our aim was to expand on a previous study describing the prevalence of palliative research at the CARO ASM.

Materials and Methods: Published abstracts (2009-2020) were independently reviewed by two authors who categorized each as: curative-intent; palliative-intent; pertaining to or including both populations; or neither. Abstracts were considered palliative if they described incurable malignancy and interventions primarily for symptom control or QoL. Studies evaluating ablative-intent stereotactic RT were not considered palliative. Type of study, primary, site treated, symptoms palliated and regions of authorship were recorded. Descriptive and summary statistics were calculated including one-way ANOVA and chi-square test for trend.

Results: Two hundred twenty-two 2995 abstracts (7.4%, range 2.4-13.9% per year) were classified as palliative. 9.9% described Phase I-III trials while 37.4% were retrospective. Primary sites were mainly lung (31/222) and genitourinary (16/222); 64.9% aggregated multiple primaries. Most commonly treated metastases were bone (36.0%) and brain (12.6%); 22.1% grouped multiple sites. QoL, symptom and toxicity outcomes were reported in 32.4%, 27.0% and 17.1%, respectively. The most common specific symptom palliated was pain (23/222) but reporting multiple symptoms was common (30/222). One third were authored by investigators from Ontario and 33/222 were from a dedicated PRT program. This proportion of palliative abstracts is not significantly different from previous: 7.6% presented from 2003 to 2008 (p=0.99), and 6.7% from 1992 to 2002 (p=0.77) were palliative, confirmed by trend analysis examining all years 1992-2020 (p=0.47).

Conclusions: Despite the prevalence of PRT in clinical practice, the proportion of palliative-focused abstracts presented at the CARO ASM has not significantly changed in almost 30 years. Acknowledging the challenges of conducting studies in a population with limited life expectancy, PRT research represents an essential way to advance comprehensive personalized patient care.

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AN EXPLORATORY ANALYSIS OF STUDY OUTCOMES AND FOUNDATIONAL EVIDENCE FOR FIVE YEARS OF PHASE III TRIALS IN RADIATION ONCOLOGY

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Purpose: High level randomized evidence is critical to guiding clinical decision making in Radiation Oncology (RO). With fixed resources, careful question selection and pragmatic trial design is critical. We aimed to explore elements and outcomes of published Phase-III clinical (P3) trials in RO, and the evidence they were based on to inform future trial design

Materials and Methods: PubMed was queried for published randomized clinical trials, reporting the primary endpoint, utilizing radiation (RT) for malignancy in at least one intervention arm, over 5 years (2015-2019 inclusive). Trials were excluded when publishing secondary analyses, secondary endpoints, not explicitly defined as P3 in manuscript or registry, or reports where RT was not present in at least one intervention arm. Two reviewers independently screened titles, abstracts and full text articles. Relevant data were abstracted, categorized. The determination of 'best preceding evidence' informing intervention-arm design was abstracted and categorized using a standard process.

Results: Of 3,472 initial records, 177 met inclusion criteria and were abstracted, encompassing a total of 96,060 patients. 140 studies were multi-institutional with half of these being international. Thirty-seven trials were single centre. Overall survival, other survival endpoints, Toxicity/Symptom, Local/Regional Control and Pathology/radiographic response were the primary endpoint in 51(29%), 65 (37%), 27 (15%), 26 (15%) and 7(4%). Majority of studies (77%) had two arms, comparing standard therapy to the experimental intervention. A minority compared two experimental (9%) or two standard therapies (5%), or examined three or more arms (9%). Most common sites were genitourinary (18%), gastrointestinal (16%), Head and neck (16%), thoracic (13%) and breast (10%). RT was used as the primary modality (60%), neoadjuvantly (13%), adjuvantly (21%) or varied (6%). In 78 (44%) of trials, RT regimen was the same in both trial arms. In the remaining trials (56%) where RT regimen varied between arms, the trial evaluated variations on the RT technique (dose, fractionation, target volumes, delivery technique) (32%), or RT compared to another therapy (local, systemic, or observation) (24%). Forty-seven percent of the evaluated trials were considered positive for the primary endpoint. Four percent were stopped early due to poor accrual and 49% were negative. Twenty-eight percent of trials were explicitly reported as superiority designs in manuscript or protocol, 18% as non-inferiority, and 3% as equivalence. Half of the analyzed trials did not explicitly declare statistical design. Only 33% of studies had clearly cited a relevant study that has based the trial design and the sample size determination, and these sources were mostly P2 or P3 trials (83%). In reviewer-determined 'best preceding evidence', 40% were based on prior P3 studies, 23% on Phase 2 (P2) studies, 6% in Phase 1 studies, retrospective analyses (11%), prospective cohorts (5%), basic science (4%) and other (11%). Of the P2 trials, 37% were randomized and 63% single arm.

Conclusions: Summary demographics for P3 RT Trials published between 2015 and 2019 demonstrate a range of clinical questions across RT sites. The positive outcome rate of approximately 50% in this 5-year sequence of P3 trials in radiation oncology suggests a favourable research output and clinical equipoise between study arms. Foundational evidence provided by trials is heterogeneous and further study is warranted to determine predictors of trial success to maximize trial resources

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MEDICAL ASSISTANCE IN DYING IN ONCOLOGY PATIENTS: A CANADIAN ACADEMIC HOSPITAL EXPERIENCE

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Purpose: Medical assistance in dying (MAID) was legislatively enacted in Canada June 2016. MAID is performed most frequently for oncology patients. The aim of this study is to describe the patient, disease and process characteristics in this population.

Materials and Methods: We performed a single-institution review of all oncology patients who requested MAID at a tertiary care hospital between June 2016 and June 2020. A prospective database including patient demographics, terminal illness type, dates of assessment, cause of death, and date of death were used. Additional data such as demographic, oncologic, treatment-related, and symptom-related details were retrospectively collected. Descriptive statistics were reported. Our primary hypothesis is that performance status is one of the important factors associated with MAID provision.

Results: Between June 2016 and June 2020, 346 oncology patients requested and 103 received assisted death. Identifiers were available and data were retrospectively collected for 92/103 patients. Median age was 72 (range 25-97) and 54% were female. The most common primary malignancies were lung (15/92, 16%), pancreaticobiliary (14/92, 16%), colorectal (13/92, 14%), and hematologic malignancy (11/92, 12%). Performance status was documented for 60 patients within one week of MAID provision; 90% of patients (54/60) had ECOG performance status of 3 or 4, and 42% patients (25/60) had ECOG performance status of 4. At the time of initial MAID request, 65% of patients (60/92) had metastatic disease, among which 52% of patients (31/60) received palliative-intent systemic therapy. Sixteen percent of patients with metastases (10/60) received at least three lines of palliative-intent systemic therapy. Median number of days from first MAID assessment to MAID provision was 7 days (range 0 to 349 days). Sixty-seven percent of patients (60/89) received MAID within 10 days of first MAID assessment and 87% (77/89) within 30 days. The most common debilitating symptoms were uncontrolled pain (53%, 49/92), fatigue (37%, 34/92), and dyspnea (27%, 25/92).

Conclusions: Ninety percent of oncology patients who received MAID had ECOG performance status of 3 or 4 which is reflective of patients' poor prognosis and limited ability to perform daily activity. The median time interval between first MAID assessment to MAID received was seven days and most patients received MAID within 30 days.

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ADOPTION AND IMPLEMENTATION OF SINGLE FRACTION LUNG STEREOTACTIC ABLATIVE RADIOTHERAPY IN A MULTI-CENTRE PROVINCIAL CANCER PROGRAM DURING THE COVID-19 PANDEMIC

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Purpose: The COVID-19 pandemic forced cancer centres worldwide to consider shortened radiotherapy regimens to minimize the risk of infectious exposure of patients and staff members. The process of obtaining consensus and implementation of new treatment approaches can be more challenging in larger institutions with multiple treatment centres. We describe the implementation of single fraction (SF) lung stereotactic ablative radiotherapy (SABR) in a multi-centre provincial cancer program.

Materials and Methods: In a Canadian province with a provincial cancer program, radiotherapy services are distributed across six regional centres. In March 2020, provincial mitigation strategies were developed in the event of severe limitations on radiotherapy access during the COVID-19 pandemic. The provincial lung radiation oncology group identified SF lung SABR as a mitigation measure supported by high quality randomized evidence that could provide comparable outcomes and toxicity to existing fractionated SABR protocols. A working group of radiation oncologists and medical physicists performed a literature review and drafted provincial consensus guidelines and procedures. The guidelines were reviewed by a group of centre representatives as a component of provincial lung radiotherapy mitigation strategic planning. Individual centres were encouraged to implement SF lung SABR as their resources and staffing would allow. Centres were then surveyed about barriers to implementation.

Results: On March 24, 2020, a working group was created and consensus guidelines for SF lung SABR were drafted. The final version was approved and distributed by the working group on March 26, 2020. The provincial lung radiotherapy mitigation strategy group adopted the guidelines for implementation on April 1, 2020. Implementation was completed at the first centre on April 27, 2020. Barriers to implementation were identified at the remaining five centres. Two centres located in regions with disproportionately high numbers of positive COVID-19 cases described inadequate staffing as an impediment to implementation. One centre experienced delays due to pre-scheduled commissioning of new treatment techniques. Three centres cited competing priorities as reasons for delay. As of February 2021, two centres had active SF lung SABR programs in place, three centres were in the process of implementation, and one centre had no immediate plans for implementation due to ongoing resource issues.

Conclusions: SF lung SABR was introduced in a multi-centre provincial cancer program within weeks of conception through rapid communication during the development of pandemic mitigation strategies for radiotherapy. Although consensus guidelines were adopted quickly, the actual implementation by individual centres was variable due to differences in resource allocation and staffing among the centres. Strong organizational structures and early identification of potential barriers may improve the efficiency of adopting new treatment initiatives in large distributed radiotherapy programs.

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BARRIERS TO ACCESS PALLIATIVE RADIOTHERAPY FOR PROSTATE CANCER IN ONTARIO

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Purpose: With improvements in systemic therapy, patients with metastatic malignancies are living longer; however, access to adequate palliative radiotherapy remains an issue. In this study, we aim to describe factors important in access to palliative radiotherapy in patients who received novel Androgen receptor-axis-targeted therapies (ARAT) and died of prostate cancer. The main objective of this investigation was to identify and describe the factors important to receipt of palliative radiation treatment and the barriers to access in patients with prostate cancer in Ontario.

Materials and Methods: Population-based administrative databases from Ontario, Canada were used to identify patients 65 years or older with prostate cancer who were eligible for Ontario Drug Benefit 2002-2018 (n=138,976), received continuous androgen deprivation therapy (ADT, n=37,578), and died of prostate cancer-specific death between 2013-2017 (n=3,575). Baseline and treatment characteristics were analyzed for association with receipt of radiotherapy in a two-year observation period prior to death.

Results: 48.4% of patients who were included in the study received palliative radiotherapy to bone in the two years preceding death despite 51.3 % presenting with metastasis. Potential barriers to access to radiation treatment in patients with lethal castration-resistant prostate cancer in Ontario include cancer centre consultation, type of oncologist involved, patient distance to cancer centre, or socioeconomic factors, such as income quartile and rurality index. Detailed analysis of the results will be available at the time of presentation.

Conclusions: The role of palliative radiotherapy has become increasingly recognized constituting nearly half the courses of radiation therapy delivered in Ontario. However, unimpeded access to radiation therapy continues to be a challenge, as evident from a high proportion of patients dying of prostate cancer in Ontario who never received palliative radiotherapy. We aimed to identify socioeconomic factors that might have accounted for the gap between the actual and optimal rates of receipt of radiotherapy to be able to improve the quality of life of many incurable patients.

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RADIOTHERAPY DECISION MAKING IN A PANDEMIC: ALBERTA'S EXPERIENCE DURING THE FIRST WAVE OF COVID-19

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Purpose: To examine deviations to radiotherapy standard practice in the province of Alberta due to the onset of the COVID-19 pandemic.

Materials and Methods: The Canadian partnership for Quality Radiotherapy developed a questionnaire for radiotherapy departments across Canada to track clinical deviations in decision making. The questionnaire is available (www.cpqr.ca) to use and/or adapt for each centre's needs and captures patient-specific characteristics, COVID-19 status, and deviations to standard care received. In this study, the CPQR questionnaire was completed by the physician at the time of initial radiation oncology consult. It was implemented in Alberta provincially on May 11, 2020 and retrospectively populated to include patient data from March 1, 2020.

Results: From March 1, 2020 to July 31, 2020, there were 10,900 recorded COVID-19 positive cases in the province of Alberta. During this time period, 2110 questionnaires were completed, with 162 (7.7%) reporting that standard practice was not followed. Of the 162 reporting non-standard practice, 150 (7.1%) patients had a change to intended timing or dose regimen, and 12 (0.6%) patients did not receive radiotherapy. Among tumour-site groups, breast patients had the largest proportion (30.3%) of deviation from standard practice, followed by hematologic (12.1%), GU (7.2%), gynaecologic (6.3%), lung (4.7%), CNS (3.6%), and GI (1.4%).

To reduce total treatment visits, hypofractionation regimes were introduced: Accelerated partial breast irradiation (APBI) 27Gy in 5 fractions; 40Gy in 15 fractions; Fast forward regime, 26Gy in 5 fractions. The latter was adopted as a standard of care option in June 2020.

Conclusions: The total number of patients that had a deviation from standard practice was minimal. Only breast cancer patient group showed a significant change, facilitated by existing expertise in APBI and hypofractionation.

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VIRTUAL CARE UPTAKE IN RADIATION MEDICINE: LESSONS LEARNED FROM THE COVID-19 PANDEMIC

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Purpose: The COVID-19 pandemic precipitated operational changes to how care is delivered within radiation medicine. Prevention measures accelerated an uptake of virtual care over in-person contacts. Here we propose to describe the adoption of this visit mode in a large academic cancer program.

Materials and Methods: Four time periods of interest were used for comparison between October 2019 and December 2020; pre-COVID-19, first COVID-19 wave, in-between waves, and second COVID-19 wave. Scheduling data was extracted out of the electronic medical record. Visit types (RO consult, RO on treatment visits (OTV), RO follow-ups, nursing visits), visit modes (in-person, virtual), the patient's primary cancer diagnosis, and provider-specific data were compared across these periods. Descriptive statistics were used to analyze the information extracted.

Results: On average, the monthly number of RO follow up visits increased during the pandemic months (2077 versus 1681) and decreased for RO consults (445 versus 459) and RO on-treatment visits (966 versus 1085). The virtual visit mode was used the most during the first wave (65% of all RO visits), and at its lowest between the two waves defined (55%). Virtual mode was used the most for RO follow-ups (76%), followed by RO consults (42%). RO OTVs had the least virtual mode uptake (25%). Patients with a genitourinary cancer had the most virtual visits reported during the pandemic (86%) whereas patients with a head and neck primary had the least (36%). There was a wide range of per-provider virtual care adoption (36% to 86%). The average number of monthly in-person nursing interventions for patients decreased during the pandemic (731 versus 795).

Conclusions: The COVID-19 pandemic has forced rapid adoption of virtual care along the cancer care continuum. From our review, the visit type and the patient's primary diagnosis seemed to influence the uptake of virtual care the most. This should be taken into consideration when renewing models of care in radiation medicine.

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VIRTUAL HEALTH IN CANCER CARE: RESULTS FROM A SEMI-STRUCTURED INTERVIEW –SURVEY OF ONCOLOGY HEALTH CARE PROVIDERS

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Purpose: The COVID-19 pandemic has compelled an increased use of virtual care delivery models in oncology. This study sought to examine the views of oncology health care providers (HCP) on the value and impact of virtual care models in clinical practice.

Materials and Methods: A semi-structured interview-survey was developed to compare provider practice patterns between May 2019 and May 2020. Questions were designed to determine provider-perceived value and impact of virtual visits on clinical interactions with patients. HCP (including physicians, dentists, and nurse practitioners) at a provincial oncology institution were invited to participate. Responses to the interview questions were de-identified and HCP names were replaced with a study code. Quantitative questions were interpreted with descriptive statistics. Qualitative results were analyzed and iteratively coded by multiple reviewers for emerging themes.

Results: Among 531 invited participants, 61 completed the interview-survey and 60 were included in the final analysis. Of those interviewed, 47% were radiation oncologists and 33% were medical oncologists. The remainder of HCP interviewed (n=12) included functional imaging physicians, general practitioners in oncology, hereditary cancer physicians, nurse practitioners, palliative care physicians, psychiatrists, and surgical oncologists. Most oncology providers (87%) desired the continuation of virtual visits as part of their clinical practice so long as barriers to integration were addressed. Barriers identified included limited access to physical resources, such as hardware (70% responses) and quiet spaces (54% responses), insufficient logistic support such as information technology services (84% responses) and operational workflows (46% responses), the absence of guidelines to select patients for this delivery model (38% responses), and concerns regarding HCP liability, security and privacy (30% responses).

Conclusions: Oncology HCP value delivering patient care through virtual means, however, barriers to implementation must be better understood. These data may inform continued use and implementation of virtual care at other Canadian oncology centres.

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RADIOTHERAPY FOR MANAGEMENT OF SIALORRHEA

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Purpose: To evaluate the role of radiotherapy in management of sialorrhoea and to establish an appropriate target volume and an effective dose.

Materials and Methods: From January 2020 to February 2021, three males and three females, median age 11 years (range 4-44 years), with severe sialorrhoea associated with congenital syndromes or neurologic disorders including amyotrophic lateral sclerosis and HIV encephalitis were treated with radiotherapy. All had previously received pharmacological treatment (all had received intraglandular injection of botulinium toxin, one anticholinergic medication and one scopolamine) and one had undergone salivary gland ligation, all with unsatisfactory response.

All patients were treated with intensity modulated radiotherapy using 6MV photons. Five received 5Gy in single fraction and one 20Gy in 5 fractions. The treatment volume included bilateral parotid and submandibular glands in 5 patients and bilateral parotids alone in one patient. Response was evaluated using the Teacher drooling scale. The median follow-up was five months (range 3-12 months).

Results: Five patients (83%) had a positive response to treatment. One had a complete response and four had a partial response. Four of the five had received 5Gy in a single fraction and one 20Gy in 5 fractions. Three patients were re-treated after two, four, and 12 months from the initial treatment, one of them the only patient whose initial treatment was to parotid glands only. One patient who did not respond to the initial treatment 5Gy in single fraction had a positive response after re-treatment with a second dose of

5Gy. There was no mucositis or other acute effect and patient/parent satisfaction was high even if re-treatment was needed.

Conclusions: Radiotherapy to the salivary glands is effective in reducing sialorrhoea with no acute toxicity. Our current approach is to treat parotid and submandibular glands to a dose of 5Gy. Treatment can be repeated safely if needed.

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ACCESS TO RADIOTHERAPY IN GHANA: A GEOSPATIAL ANALYSIS

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Purpose: Radiotherapy (RT) is a crucial component of comprehensive cancer care, but there are large global gaps in access. Within Ghana, a West African country with a population of 31 million, there are only three RT centres with five external-beam (EBRT) and two high-dose rate (HDR) brachytherapy (BT) machines located in two cities in the south. This study describes the gaps in RT capacity and geographic accessibility.

Materials and Methods: A retrospective review of all RT centres in Ghana was done to determine the number of RT courses, EBRT fractions, and BT insertions for cervical cancer delivered annually between 2018-2020. Additional RT capacity required for optimal utilization was estimated from GLOBOCAN 2020 and the Collaboration for Cancer Outcomes Research and Evaluation radiotherapy utilization rate (RUR) model. A time-driven activity-based model was used to estimate the number of machines and centres required to deliver this capacity. Geospatial modeling was used to calculate current travel distances to access RT, and how access would improve with new RT centres strategically located throughout the country.

Results: In 2020, Ghana delivered 1,794 RT courses and 34,624 EBRT fractions for all cancers, and performed 497 HDR BT insertions for cervical cancer (the second most common cancer in women in the country). Based on a RUR of 48%, an additional 9,730 RT courses, 188,948 EBRT fractions and 4,538 HDR BT insertions are required. With standard operational parameters, this translates to five additional RT centres, each with four EBRT units and one HDR BT afterloader.

Based on current capacity and centre location, patients have a median one-way travel distance from their regional capital to the nearest RT centre of 157 km, with 54% of patients traveling less than 100 km, 15% traveling 100-150 km, 9% traveling 150-200 km, and 22% traveling >200 km. The North East, Upper East, and Upper West regions have the longest travel distances of 424 km, 533 km, and 439 km, respectively. Establishing a new RT centre in Tamale in northern Ghana would decrease median one-way travel distance from the regional capitals to the nearest centre to 145.5 km, and the proportion of the population with a travel distance >200 km to 4%. Optimizing the location of other new centres is needed to further reduce travel distances.

Conclusions: Ghana has a major national deficit of RT capacity, with significant geographic disparities among regions. Well-planned infrastructure scale-up that accounts for the population distribution can improve RT accessibility.

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COVID-19 PANDEMIC IMPACT ON RADIATION TREATMENT DELIVERY METRICS

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Purpose: Enhanced Infection prevention measures used during the COVID-19 pandemic have likely increased the time radiation therapists (RTs) need to treat patients, therefore potentially reducing treatment capacity. Here we propose comparing radiation treatment delivery metrics pre- and during COVID-19 at a large Canadian radiation treatment program.

Materials and Methods: Appointment information and timestamps on patient arrival, treatment mode up and completion for patients treated on nine linear accelerators between January 1, 2020 and June 22, 2020 were extracted from the electronic radiation treatment record. Data points collected (n=23,761) were initially reviewed for validity. 23,333 radiation treatment appointments were retained for analysis and divided into two comparison cohorts (pre-COVID-19 January 1st - March 13th; during COVID-19 March 16th - June 22nd). Descriptive statistics were used to evaluate the timing of patient arrival against their scheduled appointment, the scheduled appointment duration, the initiation of the treatment site set-up against the scheduled appointment time, the completion of the appointment against the scheduled appointment end time, the overall time the patient spent in the department and the number of patient visits per hour.

Results: Patients arrived earlier for their treatment appointment pre-COVID-19 (mean =22.33min versus 17.10 min). The average scheduled appointment was shorter pre-COVID-19 (mean=19.91min versus 21.98 min). RTs started to set-up the patient earlier than the scheduled appointment start pre COVID-19 (mean = 0.2 min early), but later during COVID-19 (mean = 3.63 min late). RTs completed the procedure ahead of schedule for both periods (mean= 6.52 min versus 5.91 min). Patients spent more time in the radiation treatment department pre COVID-19 (35.22min versus 33.17min). More patients per hour were treated pre COVID-19 (2.68 patients/hour versus 2.33 patients/hour).

Conclusions: According to our data analysis, additional precaution measures introduced by the COVID-19 pandemic increased the amount of time RTs needed to complete treatment procedures, reduced treatment capacity and changed patients' habits while in and out of the radiation treatment department. Operational throughput assumptions may need to be adjusted to forecast future need for space, human resources and capital equipment investments if these measures extend beyond the pandemic.

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TELEMEDICINE IN RADIATION-ONCOLOGY: IS IT PERTINENT AND IS IT THERE TO STAY?

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Purpose: The COVID-19 pandemic forced the Quebec healthcare system (as elsewhere in the world) to reorganize itself in early 2020. Teleconsultation was featured as a tool to limit the exposure of patients and healthcare workers to the SAR-CoV-2 virus.

In this context, the radiation oncology department decided to review its practices and deploy teleconsultation (telephone and video) in order to reduce the number of hospital visits for its vulnerable clientele. After several months of using teleconsultation in radiation oncology, a research project was launched in pursuit of the different objectives. First, analyze the perceptions of radio-oncologists as well as their behavior in connection with the use of teleconsultation in the department. Second, identify the conditions where teleconsultation would be relevant in radio-oncology post-pandemic. And finally, make recommendations

to ensure the sustainability of teleconsultation in radio-oncology.

Materials and Methods: A case study was carried out in the radio-oncology department. A total of 15 semi-structured interviews were conducted in the fall of 2020, 13 with doctors, one with the head of service and one with the administrative coordinator. The length of the interviews ranged from 30 to 40 minutes, and all but one interview were recorded and then transcribed. In addition, reports presenting usage statistics for each modality (face-to-face, telephone and Reacts videoconferencing) were also analyzed.

Results: The relevance of teleconsultation in radiation oncology was found to depend on three main factors. First, the patient care phase (pre-treatment, treatment or post-treatment). Secondly, the need to conduct a physical examination (yes or no). And finally, patient constraints (limited mobility, poor health, living far from the cancer centre, etc.) associated with their travelling to the hospital (high or low).

Conclusions: Ultimately, in order to ensure the sustainability of teleconsultation in radiation oncology, there are main factors to consider. First, it is essential to define clear guidelines for the use of teleconsultation to guide medical practice. It is also important to use "success stories" to legitimize the change in practice with the medical profession and administrative staff. Also, an effective change management strategy has to be elaborated (project team, internal champions, training, support, communication, involvement, etc.) to maximize adoption and use with radiation oncologists, employee and patient. Finally, the careful selection of the video-consultation application and the offer of technological support (for doctors and patients) is essential to ensure sustainability of teleconsultation in the department.

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PROGNOSTIC FACTORS INFLUENCING ONCOLOGIC OUTCOMES IN MERKEL CELL CARCINOMA: A RETROSPECTIVE POPULATION-BASED COHORT STUDY

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Purpose: Merkel cell carcinoma (MCC) is a rare, aggressive neuroendocrine skin cancer with a poorly understood etiology and a paucity of high-level evidence to guide its management. The objective of this study was to examine the presentation and outcomes related to MCC treatment at a Canadian centre.

Materials and Methods: The electronic and paper records of a population-based cohort of 75 cases of MCC identified from the Manitoba Cancer Registry between 2000 and 2019 were retrospectively reviewed. Age, gender, stage of disease at initial presentation, treatment intent and modalities used, and their oncological outcomes were recorded and analyzed using SPSS 27·0. Two-sided Pearson test was used for intergroup comparisons. Disease-specific survival (DSS) and disease-free survival (DFS) were estimated by the Kaplan-Meier product limit method and the effect of individual prognostic factors on survival was assessed by using the log rank test. Cox-proportional hazard model was used to assess the independent influence of prognostic factors on DFS and DSS.

Results: Mean age at diagnosis was 76 (SD 12), 54% were female, 35% had a history of non-melanoma skin cancer, 4% had history of melanoma, and 12% had history of immunosuppression. Most patients were treated with curative intent (83%). Five-year DSS and DFS were 57.2% and 45.7%, respectively. Head and neck was the most common site involved (59%), however, the site of MCC did not influence DSS. Forty percent of patients had pathologic Stage III/IV disease. For the patients treated with curative intent, gender or treatment modality did not impact the DSS. DSS was independently influenced by the stage of disease at presentation (HR=1.04 (95% CI=1.00-1.08; p<0.001) and the age at diagnosis (HR=1.04 (95% CI=1.00-1.08; p=0.046).

Conclusions: Stage at presentation and age at diagnosis, but not the site of MCC or radical treatment modality, were identified as independent predictors of DSS.

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DO VIRTUAL RO CONSULTS EXPEDITE TREATMENT? ANOTHER TALE FROM THE COVID-19 PANDEMIC

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Purpose: The rapid adoption of virtual care during the COVID-19 pandemic has disrupted the traditional radiation treatment planning pathways. Decisions to treat made over the phone often required additional scheduling coordination for the radiation oncologist to assess the patient at time of CT-simulation. This had the potential to delay treatment start. Here we propose to review the impact of virtual care on radiation treatment wait times.

Materials and Methods: CT-sim appointments for external beam treatment planning were retrieved from the scheduling system between October 2019 and January 2021. Visit dates were used to link initial consult and treatment start data, and to calculate wait intervals. The initial dataset was reviewed for data quality and records with missing consult or treatment start data were removed from the analysis. Excessive wait intervals were also excluded. 3116 linked CT-sim records were retained for analysis. Descriptive statistics were used to compare wait times and rates of in-person RO visits post consult.

Results: The rate of CT appointments initiated from virtual consults varied during the pandemic (mean = 32%, max = 67.2% in May 2020). This consult mode was inexistent in the 5.5 months leading to the pandemic. Average wait intervals (Consult to CT; CT to Start; Consult to Start) for patients who had a virtual consult appeared reduced (12.9 days; 8.6 days; 22.3 days) compared to in-person consults (14.0 days; 9.9 days; 26.6 days). Twenty-nine percent of CT appointments required a same day in-person RO follow-up during COVID-19 versus 7% pre-COVID-19. For those requiring a same-day in-person RO visit during COVID-19, their mean wait intervals from Consult to CT and Consult to Start increased (15.9 versus 12.1 days; 26.8 versus 24.0 days), whereas their CT to Start decreased (8.8 versus 9.7 days).

Conclusions: The introduction of virtual consults during the CV19 pandemic appeared to expedite radiation treatments. However, increased coordination for in-person RO follow-up to finalize the treatment decision contributed to an increase in radiation treatment wait times, and likely introduced additional pressures on the treatment planning team to make up for the upfront coordination delays.

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SATISFACTION AMONG CANCER PATIENTS UNDERGOING RADIOTHERAPY DURING THE COVID-19 PANDEMIC

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Purpose: The COVID-19 pandemic has shifted practices in oncology to prioritize the safety of this vulnerable group of patients while maintaining necessary treatment delivery. We sought to obtain

patient feedback on pandemic-based practices in our radiotherapy department to improve quality of patient care and amend policies as needed.

Materials and Methods: We developed a piloted questionnaire which quantitatively and qualitatively assessed patients' pandemic-related concerns and satisfaction with specific elements of their care. Adult patients who were treated at our centre between March 23rd and May 31st, 2020, had their initial consultation via telemedicine, and received at least 5 outpatient fractions of radiotherapy were invited to complete the survey by telephone or online. Relative frequencies of categorical and ordinal responses were then calculated.

Results: One hundred ten eligible patients were identified, of which 53 (48%) responded: 32 patients by phone and 21 patients online. Eighteen participants (34%) admitted to feeling anxious about hospital appointments, and only five (9%) reported treatment delays. Forty-eight patients (91%) reported satisfaction with their initial telemedicine appointment. The majority of patients responded positively to specific pandemic practices and admitted that healthcare workers took appropriate precautions, making them feel safe. Patients who were initially anxious about coming to hospital reported experiencing less anxiety after several visits. Overall, all 53 patients (100%) reported being satisfied with their treatment experience during the pandemic.

Conclusions: Patients have responded positively to the pandemic-related policies in our radiotherapy department. Patient feedback is needed to provide the highest quality of patient care as we adapt to the current reality.

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PROSTATE SBRT BOOST RADIOTHERAPY (PBS TRIAL): A RANDOMIZED PHASE II TRIAL OF SBRT VERSUS CONVENTIONALLY-FRACTIONATED RADIOTHERAPY BOOST FOLLOWING PELVIC RADIOTHERAPY IN HIGH-RISK PROSTATE CANCER

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Purpose: Curative therapy for high-risk prostate cancer (HR-PrCa) includes androgen deprivation therapy (ADT) and a long course of pelvic and prostate boost radiotherapy (RT), which adds a significant burden on patients. Several non-randomized studies in the past 10 years suggested that 3-fraction Stereotactic body radiotherapy (SBRT) regimens provide promising rates of disease control and may be able to replace the conventionally fractionated (CF) External Beam RT (EBRT) boost, improving significantly the convenience of RT treatment. To address the deficit in randomized data, we opened a regional Prostate Boost irradiation with SBRT (PBS) randomized controlled trial at Juravinski and Walker Family Cancer Centres, in 2019.

Materials and Methods: Men with localized HR-PrCa receive ADT for a total duration of three years, pelvic CF-EBRT (45-46Gy in 23-25 fractions) and are randomized to either CF-EBRT boost (32-33Gy in 15-16 fractions) or SBRT boost (19.5-21Gy in 3 fractions) to prostate and seminal vesicles. All patients receive fiducial (gold seed) implants and planning margins compatible with SBRT, regardless of treatment arm. SBRT boost is delivered with a Cyberknife unit at the Juravinski Cancer Centre or with LINAC-based VoluMetric Arc Therapy (VMAT) at the Walker Family Cancer Centre) and, therefore, cases are stratified per treatment centre. Primary endpoint is quality of life (based on EPIC), and secondary endpoints include treatment-related toxicity and biochemical control. Biospecimens are collected for future analysis. Salient methodological differences between our study and a 2-fraction randomized phase II trial reported very recently (HYPO-PROST, Nov.2020) include fiducial-guided SBRT-based boost treatment and higher dose weekly fractions of boost RT.

Results: We have completed nearly 50% of our target accrual of 100 patients. The mean age at enrollment was 73 (IQR 71-78) with a mean PSA of 12.7, IPSS score of 8.4 (IQR 4-13). 62.5% of the accrued patients had Gleason scores of 8 or higher, 23% had a PSA of 20 or higher, and 10% had findings consistent with cT3a or higher on DRE. Interim safety analysis of this trial will be completed in August 2021 and presented. To date, no Grade 3 or higher toxicity has been reported in either treatment arm. No biochemical failure has been noted.

Conclusions: Despite interruption due to the COVID-19 pandemic, accrual on this study is progressing well with no unexpected toxicity or treatment failures detected. This study provides a formal evaluation of SBRT as a boost RT technique in HR-PrCa in a randomized setting. It is an important endeavour given the potential to develop a safe and convenient treatment for HR-PrCa.

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ORGAN AT RISK DOSE CONSTRAINTS IN STEREOTACTIC ABLATIVE RADIOTHERAPY: A SYSTEMATIC REVIEW OF ACTIVE CLINICAL TRIALS

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Purpose: Organs-at-risk (OAR) dose constraints are a critical aspect of stereotactic ablative radiotherapy (SABR) treatment planning. As clinicians must balance tumour control and potential toxicities, knowledge and application of optimal dose constraints are essential to the safe and effective delivery of SABR. While standardized dose constraints have been studied and reported upon for conventionally fractionated radiotherapy, SABR dose constraints have not been as extensively studied, with limited evidence supporting preferred dose constraints for most OARs. Our objective was to report on OAR dose constraints used in ongoing clinical trials involving SABR for oligometastatic disease to help inform institutional practices.

Materials and Methods: Clinicaltrials.gov was searched from inception to February 2020 to capture actively accruing clinical trials using SABR in oligometastatic disease. Full protocols (or at minimum, a list of dose constraints utilized) were obtained by contacting principal investigators or from publicly available sources. OAR constraints were abstracted by two authors and synthesized to report in a standardized manner. Variability of OAR constraints was assessed by comparing the width of the interquartile range and the difference between the maximum and minimum dose to a volume.

Results: Fifty-three of 85 eligible clinical trials contributed OAR constraints used in analysis. Dose constraints for 1-8 fractions of SABR were collected for 33 OARs. Variability was found in the absolute allowable OAR doses, use of planning OAR volumes (PRV), and whether constraints were optional versus mandatory. For many OARs, the most common dose constraints (i.e. the mode) often matched a pre-existing publication, but no single

pre-existing publication matched the modes of all OAR dose constraints. Organs with the most variability were the rectum, penile bulb, and chest wall and ribs. The esophagus, stomach, duodenum, and small bowel also possessed high variability for at least one constraint. OARs previously evaluated by HyTEC (High Dose per Fraction, Hypofractionated Treatment Effects in the Clinic), such as spinal cord and optic pathway, appeared to have less variability among study protocols.

Conclusions: We found substantial variability in many OAR dose constraints used in ongoing clinical trials evaluating SABR in oligometastatic disease. Future research and recommendations for standardized OAR dose constraints, as well as consistency in implementing PRV margins, should be a priority for the field of radiation oncology.

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A DOSIMETRIC COMPARISON BETWEEN TRANSLATIONAL CORRECTION WITH CBCT-GUIDANCE AND ADAPTATION USING MR-LINAC FOR PROSTATE ULTRA-HYPOFRACTIONATED RADIOTHERAPY

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Purpose: Ultra-hypofractionated (>/=6Gy/fraction) radiotherapy for localized prostate cancer is delivered using daily image-guidance, with either Conebeam-CT (CBCT) or Magnetic Resonance Imaging (MRI). CBCT-Linac allows pre-delivery correction of translational displacements whereas MR-Linac enables treatment adaptation based on daily anatomy. Herein, we compared the dose to prostate and organs at risk (OARs) by these two systems.

Materials and Methods: Twenty patients recruited to a Phase 2 trial evaluating the efficacy of High Dose Rate Brachytherapy (1500cGy/1) + External Beam Radiation Therapy (EBRT) were included in this investigation. An EBRT reference plan was generated to deliver 3000cGy/5 to the prostate with a margin of 5mm using VMAT for 10 patients treated on CBCT-Linac and using IMRT for the other 10 treated on MR-Linac. Dose delivered to prostate, bladder and rectum was measured by dose calculation based on either the CBCT acquired for treatment verification, or the MR acquired during beam delivery. Delivered dose per fraction was evaluated against institutional dose constraints: Prostate D95 >600cGy, bladder D5cc <600cGy, rectum D50%, D20% and D1cc <200, 400 and 600cGy, respectively. Deviation of >+/-10% from reference plan dose was considered clinically significant.

Results: A total of 100 fractions were evaluated. Prostate D95 was acceptable for all fractions, with a mean dose of 653cGy (range 604–672cGy). Mean delivered dose to bladder and rectum was comparable between the 2 approaches, except for rectum D50 (CBCT: 98cGy versus MR: 141cGy, p<0.005). Significant deviation from the reference planned dose for bladder D5cc and rectum D50, D20 and D1cc was observed in 12%, 58%, 48% and 38% of fractions using adaptation, compared to 0%, 54%, 40% and 12% using translational correction. Although adaptation delivered a higher dose to 50% of rectum, there were 36% and 32% of fractions in which the delivered dose was significantly reduced from the planned dose for rectum D20% and D1cc. As a result, the overall mean planned dose of 296cGy was reduced to 277cGy for D20%, and from 513cGy to 473cGy for D1cc. In comparison, translation correction was able to achieve significant reduction in only 20% and 2% of fractions for rectum D20% and D1cc.

Conclusions: In ultra-hypofractionated radiotherapy, delivered dose to the prostate was similarly achieved with either translational corrections or adaptation. However, significant deviation from the reference plan dose for rectum was observed with both systems. Adaptation on MR-Linac was able to deliver a lower than planned dose to the rectum in the high dose region more frequently than translational corrections. The potential impact on toxicity is currently being investigated.

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ACUTE TOXICITY OF ULTRAHYPOFRACTIONATION COMPARED TO MODERATE HYPOFRACTIONATION IN PROSTATE CANCER TREATMENT – A RANDOMIZED TRIAL

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Purpose: To report on the early toxicities of localized prostate cancer radiotherapy up to six months after treatment in a randomized trial comparing moderate hypofractionation (MHF) to ultrahypofractionation (UHF)

Materials and Methods: The ASSERT trial is a Phase II study randomizing intermediate to high risk localized prostate cancer to radiotherapy with MHF (73.68Gy in 28 daily fractions) or UHF (36.25Gy in 5 weekly fractions). Patients were treated on linear accelerators with cone beam imaging with or without fiducials. Toxicities of treatment were assessed on both the CTCAE and RTOG/Soma scales at the end of radiation, two weeks, two months and six months after radiotherapy. Patient reported quality of life (QoL) was assessed by the EPIC questionnaire. This is a report of the toxicities and QoL findings after all patients had at least six months of follow up

Results: Eighty subjects were randomized but two patients from the MHF arm withdrew from radiotherapy. Analysis was done on 78 patients – 36 received MHF and 42 UHF radiation. Median age was 74. There were no significant differences between the two arms in age, percentage of high-risk disease, comorbidities or T stage. However, the UHF arm was found to have a statistically significant worse baseline urinary function (IPSS >7: 68% versus 36% p=0.004).

Percentages of patients who had at least one CTCAE or RTOG Grade 3 toxicity during and up to six months after treatment were: MHF 8% (GU 6%, GI 3%), UHF 2% (GU 2%, GI 0%) p=0.235. The corresponding numbers for Grade 2 toxicity were: MHF 36% (GU 25%, GI 14%), UHF 24% (GU 19%, GI 7%), p=0.235. Significant decline in urinary symptoms assessed by rise of IPSS score of at least 5 in the post-treatment period were MHF 65% versus UHF 51% p=0.355. Quality of life was analyzed along three domains: Incontinence, irritative/obstructive and bowel domains. Clinically important changes in QOL were scored if there was a "minimally important change" (MIC) of the QOL scores in the respective domain. There were no significant differences between the two arms in percentages of patients with MIC in all three domains. The percentages in the respective domains were: Incontinence - MHF 36%, UHF 33%; irritative/obstructive – MHF 56%, UHF 74%; bowel – MHF 58%, UHF 52%.

Conclusions: Despite worse baseline urinary function in patients receiving UHF radiotherapy, there were no significant differences in toxicities and quality of life changes between UHF and MHF up to six months after treatment.

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OUTCOMES OF STEREOTACTIC ABLATIVE RADIATION THERAPY FOR LIVER METASTASES FROM COLORECTAL CARCINOMA

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Purpose: Stereotactic Ablative Radiotherapy (SABR) is a recognized therapeutic option for patients with inoperable oligometastatic colorectal carcinoma (CRC). Given the scarcity of prospective data on outcomes of SABR for metastatic CRC, this study aims to review SABR outcomes and determine any predictive factors of local control and survival in patients with liver metastases from CRC.

Materials and Methods: All provincial CRC liver metastases patients are referred to a single institution for SABR. A retrospective review of SABR patients between September 2011 and August 2019 was undertaken. Endpoints included local control (LC), overall survival (OS), progression-free survival (PFS) and time to restarting systemic therapy. Univariate and multivariable analyses (MVA) were performed to identify predictive factors.

Results: Forty-eight patients were identified. The total number of tumours treated were 58. Median follow-up was 26.6 months. Local control at one, two and three years was 92.7%, 80.0% and 61.2% respectively. Median time to local failure for all patients was 40.0 months (95% CI 35.8 - 44.2 months). Median overall survival for all patients was 31.9 months (95% CI 22.1 – 41.6 months). Overall survival at one, two and three years was 79.2%, 61.7% and 44.9% respectively. Median time to disease progression in any site within the body was 7.1 months (95% CI 4.5 – 9.7 months). Disease-free survival at one, two and three years was 31.4%, 17.3% and 10.8% respectively. Thirty-three patients (69%) restarted systemic therapy after completion of SABR upon disease progression. Median time to restarting chemotherapy was 11.0 months (95% CI 8.0 – 14.1 months). Systemic therapy free survival at one, two and three years was 45.7%, 29.6% and 22.6% respectively. On MVA, inferior local control was influenced by GTV volume ≥40cm^3 (HR: 3.805, 95% CI 1.376-10.521, p=0.01) and PTV V100% BED <100Gy$_{10}$ (HR 2.971, 95% CI 1.110-7.953; p=0.03). Inferior overall survival was associated with PTV volume ≥200cm^3 (HR 5.679, 95% CI 2.339-13.755; p<0.001)

Conclusions: SABR is an effective therapeutic option for selected patients with CRC liver metastases providing acceptable local control within the first two years after completion. In some cases, it may even provide patients with a delay in recommencing systemic therapy. Higher biological effective doses are required to enhance local control.

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STEREOTACTIC BODY RADIOTHERAPY (SBRT) FOR THE PALLIATION OF UNIRRADIATED MUCOSAL HEAD AND NECK TUMOURS

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Purpose: We report the treatment outcomes of palliative SBRT to primary mucosal unirradiated head and neck cancer (HNC) patients that were ineligible to receive conventional radiation therapy (RT).

Materials and Methods: We retrospectively reviewed patients with primary mucosal HNC treated with SBRT from 2011-2020. Patients with histologies other than squamous cell carcinoma, with primary skin disease or with recurrent tumours were excluded. SBRT was used in this cohort of patients because of associated comorbidities that precluded full course RT. All patients were followed regularly with clinical examination and imaging. The endpoints were local failure (LF) defined as recurrence of tumour at the irradiated site, overall survival (OS), acute and late Grade 3 and 4 toxicity.

Results: Sixty patients with a median age of 81 years were treated with SBRT technique. The median follow-up was 7.8 months. Eight (13%), 38 (63%), 13 (22%) and one (2%) were ECOG 1, 2, 3 and 4, performance status respectively. Oral cavity was the most common cancer site in our cohort (60%, 36 patients), followed by oropharyngeal cancer (15%, nine patients), larynx (7%, four patients), hypopharynx (5%, three patients), parotid cancer (5%, three patients), unknown primary (5%, three patients) and nasal cavity/sinonasal cancer (3%, two patients). Tx-2 and T3-4 lesions were found in 18(30%) and 42(70%), respectively, while 32(53%) and 28(47%) were staged N0-1, N2-3, respectively. GTV was prescribed to 45Gy in 5 fractions, most commonly used (55%), followed by 40Gy in 5 fractions (37%). A high dose CTV was not used around GTV although an elective nodal volume of 25Gy in 5 fractions was also used. Fifty-two patients were treated twice a week completed in 13-20 days, two patients completed their treatments in 9 and 10 days, while five patients over 21-28 days.

The cumulative incidence of LF at six and 12 months was 5.3% (95% CI 1.4-13.3) and 12.4% (95% CI 4.9-23.7), respectively. The actuarial median (OS) was 9.2 months. The six- and 12-month OS rates were 67.9% (95% CI 56.6-81.4) and 41.4% (95% CI 29.2-58.7), respectively. Cancer was the cause of death in 12 patients (38%), while 20 deaths (62%) were not related to malignant disease. Acute G3 toxicity was observed in 23 patients, including G3 mucositis in 19 patients, G3 dermatitis in two patients and G3 dysphagia in two patients. Five patients developed G3+ late toxicity, including osteoradionecrosis (n=3), soft tissue supraglottic ulceration (n=1) and trismus (n=1). Four of these five patients did not have evidence of concurrent local recurrence.

Conclusions: HN SBRT has been largely reported in the re-irradaition setting, however, SBRT may have greater utility in the palliative management of previously untreated HNC patients. Despite the advanced age and performance status noted in this group of patients with mucosal SCC of the head and neck, who were not eligible for conventional RT, SBRT was associated with low local failure rates and reasonable toxicity profile. A randomized controlled trial is warranted to confirm the efficacy of HN SBRT in this setting.

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PREOPERATIVE DURAL CONTACT CORRELATES WITH THE RISK OF NODULAR LEPTOMENINGEAL FAILURE FOLLOWING ADJUVANT STEREOTACTIC RADIOSURGERY

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Purpose: Surgical resection followed by adjuvant stereotactic radiosurgery (SRS) has become a widely accepted treatment modality for brain metastases (BM). Compared to Whole Brain Radiation (WBRT), this approach achieves equivalent overall survival (OS) while reducing cognitive toxicities and preserving quality of life. However, this method of treatment is associated with a unique pattern of treatment failure, ¨nodular leptomeningeal disease" (nLMD), that is distinct in terms of behaviour, prognosis and management compared to classic leptomeningeal disease (cLMD). We aimed to identify factors associated with the incidence of nLMD in surgical cavities treated with SRS.

Materials and Methods: After identifying all patients treated with surgery and SRS of BM from a prospective registry, magnetic resonance imaging **(**MRI) before and after surgery were used to characterize tumours on the basis of dural contact, size and location. We also determined whether treatment volumes (TV) included the surgical tract or the pre-surgical areas of tumour contact with sinus or dura and, if so, whether that was expanded by a 1-5mm or 6-10mm margin. Failures were classified as nLMD, cLMD, or local failure (LF). Survival rates were calculated using the Kaplan Meier method. Outcomes for nLMD, cLMD, and LF were calculated using the cumulative incidence method. The difference in groups was tested using the Fine-Gray competing risk model.

Results: One hundred thirty patients with 132 cavities were identified. Median patient age was 61.5 (23-90), median number of BM was 1 (1-10), median target volume was 15.1cc (4-54). Twenty-one percent of tumours were infratentorial. Ninety-seven tumours contacted the dura pre-operatively. OS at 12 and 24 months was 68% and 39%, respectively. Cumulative incidence of nLMD at 12 and 24 months was 17% and 22%, respectively and for cLMD it was 3% and 6%, respectively. The incidence of LF at 12 and 24 months was 10% and 17%, respectively. OS following nLMD versus cLMD at six and 12 months were 49% and 29%, and 29% and 0%, respectively. Of the factors examined, only pre-surgical dural contact correlated with time to nLMD failure (HR 0.2 (0.05-0.81) (p=0.024). No factors examined correlated with time to cLMD failure. Among nine patients for whom a 6-10 mm dural margin was added to the region of pre-surgical dural contact, there were no nLMD.

Conclusions: Preoperative dural contact correlated with time to nLMD but not cLMD. Patients with nLMD lived longer than those with cLMD. Including the surgical tract, the radiation target did not influence time to nLMD or cLMD.

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T-DM1 INCREASES THE RISK OF SRS-INDUCED RADIATION NECROSIS IN HER2+ BREAST CANCER

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Purpose: Stereotactic radiosurgery (SRS) is an important treatment modality in the management of breast cancer-related brain metastases (BrM). Recent research has found Traztuzumab emtansine (T-DM1) to be effective against Her2+ BrM. However, the risk of radionecrosis (RN) with T-DM1 in combination with SRS is unclear. The objective of this study was to investigate factors associated with RN post-SRS in patients with Her2+ BrM.

Materials and Methods: Patients with Her2+ BrM treated with SRS at the Sunnybrook Odette Cancer Centre between 2010 and 2020 were retrospectively identified. The incidence of RN was determined on a lesion-by-lesion basis using serial brain imaging with or without histological confirmation. Clinical factors associated with RN, such as age, RT dose, lesion volume, intracranial location, total number of BrM, along with history of whole brain RT, and T-DM1 treatment were investigated with univariable and multivariable competing risks regression (MVR) using death from any cause as a competing risk factor. A p-value of <0.05 in MVR following backward selection was considered statistically significant.

Results: Sixty-seven patients with Her2+ BrM (223 lesions) treated with SRS were identified; among them, 21 (31.3%) were treated with T-DM1 post-SRS, including 14 (20.9%) who received T-DM1 within 12 months of SRS. The median follow-up was 15.6 (IQR 5.4-35.3) months. The one-year, and two-year risk of RN post-SRS was 6.7% (95% CI 2.7-10.7%), and 15.2% (95% CI 9.2-21.3%), respectively. MVR identified T-DM1 treatment post-SRS (HR 2.5, 95% CI 1.2-5.3, p=0.02) and RT dose with a biologically effective dose (BED) >50.4Gy (HR 2.4, 95% CI 1.1-5.1, p=0.02) as independent risk factors of RN. Patients treated with T-DM1 and SRS had a 25.2% (95% CI 12.8-37.6%) risk of RN at both 1- and 2-years post-T-DM1. The median time to RN after T-DM1 among the affected was 4.8 (95% CI: 3.8-25.6) months with 80% of all RN cases occurring within 12 months of T-DM1 treatment.

Conclusions: This study demonstrates that T-DM1 exposure post-SRS was independently associated with a higher risk of RN in Her2+ BrM patients. The potential side effects of brain-penetrating targeted agents post-SRS merit greater awareness.

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PROSTATE SBRT WITH REAL-TIME TUMOUR TRACKING – REAL-WORLD EXPERIENCE

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Purpose: Stereotactic body radiotherapy (SBRT) allows for the delivery of highly conformal radiation doses to tumours, and recent trials have demonstrated the safety and efficacy of using SBRT for prostatic adenocarcinoma. At our institution we use automated intra-fractional motion monitoring using either fiducial markers with a triggered imaging / auto beam hold function or electromagnetic, implanted, real-time tumour tracking beacons (Calypso™) to ensure accuracy of treatment delivery. As this technique continues to be adopted, we aspired to present two motion monitoring methods used at our centre.

Materials and Methods: For this quality assurance exercise, patients underwent SBRT with either Calypso beacons or standard gold seed fiducial markers. All patients were treated with 36.25Gray in 5 fractions to the planning target volume consisting of a 4mm isotropic expansion of the clinical target volume. All patients eligible for SBRT prostate treatments are offered it. Calypso-based treatments were performed with continuous monitoring of the electromagnetic signal from the beacons with no images taken during treatment delivery. For patients treated with Calypso beacons, a beam-hold resulted if the centroid of the three beacons moved ≥3mm from its planned position. Fiducial marker-based treatments used the triggered imaging / auto beam-hold function with images acquired every five seconds during treatment delivery to ensure target positioning. If any individual seed was ≥4mm from its planned position, a beam hold would result. After the start of the SBRT prostate program, equipment was updated to a 6 degree of freedom couch and was used for 125 of the fiducial marker fractions.

Results: To date, 44 patients have completed SBRT prostate treatments of which, 32 were treated with fiducial markers corresponding to a total of 160 fractions, and 12 were treated with Calypso beacons corresponding to 60 fractions. Of the Calypso treatments, 5 fractions (8.3%) required couch shifts due to intra-fraction motion, and 36 fractions (60%) required no beam-holds. For fiducial marker treatments, intra-fraction couch shifts were required after beam-holds in 42 fractions (27.1%). Couch corrections were an average absolute roll of 0.4 degrees and average absolute pitch of 1.6 degrees.

Conclusions: In this quality assurance exercise, both fiducial markers and Calypso beacons were used to safely treat prostate patients with SBRT technique. Calypso beacons have a different method of monitoring allowable target movement and both have

been successfully utilized at our centre.

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EARLY STAGE LUNG CANCER STEREOTACTIC BODY RADIATION THERAPY OUTCOMES IN A SINGLE INSTITUITON

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Purpose: The gold standard treatment of Stage I non-small cell lung cancer (NSCLC) is surgical resection. Radical curative intent radiation therapy can provide durable local control (LC) and overall survival (OS) for medically inoperable patients. Stereotactic body radiation therapy (SBRT) is a relatively new modality with studies suggesting three-year LC close to 90%. This retrospective study focuses on the outcomes of Stage – I NSCLC patients treated with SBRT comparing to other different radiation therapy modalities at our institution between 2015 and 2020.

Materials and Methods: This study was approved by our institution's Research Ethics Board (REB). We collected a total of 139 consecutive patients' data who received SBRT (48Gy/4 or 60Gy/8), hypofractionation (60Gy/15), conventional fractionation (60Gy/30 or 50Gy/20), and palliative radiation (20Gy/5, 30Gy/10, or 40Gy/15). The primary and secondary endpoints were LC and OS, respectively. Kaplan-Meier curves were plotted for LC and OS. We also performed Cox's proportional hazard regression analysis.

Results: Median patient age was 74 (range 52-91). The numbers of patients in each treatment subgroups were: SBRT (44), hypofractionation (78), conventional fractionation (eight), and palliative (nine). Median post treatment follow-up in months for each subgroup were: SBRT (20.2), hypofractionated (20.7), conventional fractionation (13.9), and palliative (14.4). Post-treatment three-year LC was found to be significantly better with SBRT (94%), versus hypofractionation (71%), conventional fractionation (80%), and palliative (71%). OS at three years were SBRT (67%), hypofractionation (59%), conventional fractionation (66%), and palliative (44%). Proportion of patients who experienced post-treatment radiation pneumonitis or dermatitis were: SBRT (7%, 2%), hypofractionation (8%, 3%), conventional fractionation (13%, 25%), and palliative (0%, 0%), respectively.

Differences in age and gender between subgroups were not statistically significant. Every 20 years of age had 3.2x risk of death (95% CI: 1.425—7.268). With respect to the treatment modalities, there were significant differences for hazard of death compared to SBRT: hypofractionation had 2.58x increased risk while palliative had 5.83x increased risk.

Conclusions: In conclusion, our experience confirms SBRT can provide durable local control with comparable rate of post-treatment complications versus other radiation modalities for early stage NSCLC.

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SURGICAL RESECTION(S) PLUS STEREOTACTIC RADIOSURGERY (SRS) VERSUS SRS ALONE FOR LARGE BRAIN METASTASES: A COMPARATIVE STUDY

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Purpose: Large brain metastases (BM) are challenging to manage. Therapeutic options include SRS or surgery (S) plus SRS. We sought to compare the following outcomes: overall survival (OS), local failure (LF), radionecrosis (RN), pachymeningeal (PM) and leptomeningeal (LM) in patients treated with Gamma Knife (GK) SRS alone versus S+SRS.

Materials and Methods: We reviewed a prospective registry database of BM patients treated from 2008 to 2019. All patients at least 18 years old with large BM (≥4cc in volume) treated with SRS or S+SRS were included in this analysis. Exclusion criteria included the absence of post-treatment follow-up. WBRT or SRS targeting the index lesion were censoring events. Survival percentages were calculated using the Kaplan-Meier method. Differences between groups were tested using the Cox proportional hazards model. Other outcomes were calculated using the cumulative incidence method.

Results: Three-hundred eighty-three BM patients were identified, 128 and 255 were treated with S+SRS and SRS, respectively. Median ages in the S+SRS and SRS groups were 62.2 (23.6-98.5) and 60.2 (20.2-97.4), respectively (p=0.33). Median target volumes for S+SRS and SRS were 15.1cc (4-54) and 6.5cc (4-36.9) (p<0.001) respectively. Median number of BMs treated concurrently with the index lesion for the S+SRS and SRS groups was 1 (1-10) and 2 (1-11), respectively (p=<0.001). OS at 12 and 24 months was 69% and 41% versus 55% and 20% for the S+SRS and SRS groups, respectively hazard ratio (HR) 1.64 (1.23-2.18) (p<0.001). Cumulative incidence of LF requiring salvage surgery at 12 and 24 months were 3% and 5% versus 8% and 10% for S+SRS and SRS groups, respectively (p=0.067). Incidence of RN at 12 and 24 months were 9%, and17% versus 15%, 21% for S+SRS and SRS groups, respectively 1.32 HR (0.77-2.29) (p=0.32). Cumulative incidences of PM disease at 12 and 24 months were 16% and 21% versus 3% and 7% for S+SRS and SRS groups, respectively HR 0.26(0.12-0.56) (p<0.001). Cumulative incidences of LM disease at 12 and 24 months were 4% and 6% versus 2% and 4% for S+SRS and SRS groups, respectively HR 0.73(0.25-2.17) (p=0.57).

Conclusions: In this series, the addition of S to SRS correlated with improved OS and a trend towards a lower incidence of LF compared to SRS alone. However, patients treated with S showed an increased risk of PM failure.

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STEREOTACTIC ABLATIVE RADIOTHERAPY VERSUS CONVENTIONAL FRACTIONATED RADIOTHERAPY FOR EARLY-STAGE NON-SMALL CELL LUNG CANCER: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RANDOMIZED TRIALS

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Purpose: Stereotactic ablative radiotherapy (SABR) has been increasingly used for the treatment of inoperable early-stage non-small cell lung cancer (ES-NSCLC). In this setting, SABR has been shown to provide promising local control in various prospective trials. However, randomized trials have shown conflicting results in terms of whether SABR confers a survival advantage compared to conventional fractionated radiotherapy (C-RT). We conducted a systematic review and meta-analysis to investigate the efficacy and toxicities of SABR compared to conventional radiotherapy based on randomized comparisons.

Materials and Methods: A systematic review of MEDLINE (PubMed) and Embase (inception to December 2020) was performed of early-stage NSCLC patients randomized to SABR versus C-RT. Two independent reviewers screened titles, abstracts and manuscripts. Estimates and Confidence intervals (CI) were abstracted, and a random-effects model was used to estimate treatment effects. Q-test was used to assess heterogeneity. Toxicity outcomes were

compared by the Cochran-Mantel-Haenszel method.

Results: Literature search identified a total of 1494 studies, and after exclusion of duplicates, 1327 were screened. Studies were excluded in title screen (n=1209) and abstract review (n=102); 16 studies were included for full text review. Two randomized trials were identified, including a total of 203 patients, of which 115 (57%) received SABR, and 88 (43%) received C-RT. Weighted mean age was 74 years and 48% of patients were male. Most patients had T1 cancers (67% T1 versus 33% T2). Of those with T2 cancers, 64% received SABR and 36% received C-RT. Most patients were ECOG 1 (65%), and 22% and 12% were ECOG 0 and 2, respectively. SABR was delivered as 45Gy in 3 fractions (at periphery of planning target volume), 54Gy in 3 fractions or 48Gy in 4 fractions. C-RT was delivered as 70Gy in 35 fractions, 66Gy in 33 fractions or 50Gy in 20 fractions. SABR was not associated with significant improved overall survival (Hazard Ratio: 0.84; 95% CI 0.34-2.08, p=0.71). There was no significant difference in number of local failures between SABR and C-RT (Relative Risk: 0.59; CI 0.28-1.23, p=0.16). Examined adverse events of cough, dyspnea, pneumonitis, esophagitis, pulmonary fibrosis, and rib fractures were similar between groups. However, one Grade 4 toxicity of dyspnea was reported for SABR.

Conclusions: This systematic review and meta-analysis of randomized trials fails to confirm improvements in LC or OS of SABR over C-RT in ES-NSCLC, despite widespread adoption and extensive single-arm prospective and retrospective studies suggesting benefit. This small sample size is likely underpowered to detect clinically significant differences. Toxicity profile and events were similar.

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EFFECTIVENESS OF SURFACE-GUIDANCE IN DETECTING INTRAFRACTION MOTION FOR FRAMELESS, LINEAR ACCELERATOR-BASED STEREOTACTIC RADIOSURGERY AND FRACTIONATED STEREOTACTIC RADIOTHERAPY WHEN EVALUATED USING POST-TREATMENT CBCT

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Introduction: Frameless, linear accelerator (Linac) based stereotactic radiosurgery (SRS) and fractionated stereotactic radiation therapy (FSRT) are effective non-invasive treatments for intracranial lesions. The high doses and small margins used in stereotactic treatments require high accuracy of treatment delivery. As this accuracy can be compromised by intrafraction motion, it is important that this motion is effectively detected and corrected. This study aims to quantify intrafraction motion and evaluate the accuracy of SRS and FSRT treatments at our institution.

Materials and Methods: The current CCI SRS/FSRT protocol includes AlignRT surface guidance with pre-treatment and post-treatment CBCT. All patients who received frameless SRS/FSRT for intracranial lesions following our institution's protocol between June 2017 to December 2020 were included in this study. Researchers compared pre-treatment and post-treatment CBCT images to quantify intrafraction motion via image registration in Eclipse. All matches used the skull as the primary match structure due to its stability. The sensitivity of AlignRT to detect intrafraction motion and halt treatment were evaluated by confirming that the fractions with intrafraction motion values exceeding tolerance (≤1 mm for translations, ≤1.0˚ for rotations) had records of halted treatment on Eclipse. Any inconsistencies were noted for follow-up.

Results: There were a total of 54 fractions evaluated for 18 SRS and 26 FSRT patients. Average translational intrafraction motion was 0.20 ± 0.15 mm, 0.11 ± 0.08 mm (range: -0.4 mm, 0.3 mm), 0.15 ± 0.18 mm (range: -1.4 mm, 0.3 mm), and 0.09 ± 0.07 mm shifts (range: -0.1 mm, 0.37 mm) in the vertical, longitudinal and lateral directions respectively. Average rotational magnitude was 0.18 ± 0.13˚, with 0.14 ± 0.15˚ (range: -0.3˚, 1.1˚), 0.07 ± 0.08˚ (range: -0.47˚, 0.13˚), and 0.08 ± 0.06˚ (range: -0.1˚, 0.23˚) shifts in pitch, roll, and yaw respectively. AlignRT triggered the beam to shut off for 12 patients and 18 fractions. 10 patients and 16 fractions were under the tolerance once shift values were acquired and 2 patients had over tolerance movement detected by AlignRT. AlignRT did not detect intrafraction motion in 3 patients with values exceeding tolerance indicated by post-treatment CBCT values. One patient exceeded tolerance with values of 1.3 mm and 1.5˚ in the vertical and pitch directions respectively, one patient had a yaw shift of 1.1˚, and another patient had a longitudinal shift of 1.6 mm.

Conclusions: The average translational and rotational motion observed being below the predefined tolerance displays the efficacy of our institution's SRS and FSRT protocol in relation to intrafraction motion. Despite AlignRT detecting under tolerance motion, the surface guidance system was able to detect motion exceeding tolerance to limit treatment outside tolerance. Since intrafraction motion is found to be minimal for patients treated at the CCI, this research informs other institutions of the effectiveness of this immobilization protocol and validates the use of AlignRT for Linac-based SRS and FSRT.

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DYNAMIC CONTRAST-ENHANCED CT AND MRI TO EVALUATE RESPONSE IN NEUROENDOCRINE LIVER METASTASES TREATED WITH EVEROLIMUS AND RADIATION

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Purpose: The optimal method to evaluate response in neuroendocrine liver metastases (NELM) treated with radiotherapy (RT) is unknown; tumour perfusion parameters were measured by dynamic contrast-enhanced CT and MRI (DCE-CT and -MRI) to evaluate changes with treatment and correlate with efficacy in a pilot study combining everolimus with RT for NELM. PURPOSE: The optimal method to evaluate response in neuroendocrine liver metastases (NELM) treated with radiotherapy (RT) is unknown; tumour perfusion parameters were measured by dynamic contrast-enhanced CT and MRI (DCE-CT and -MRI) to evaluate changes with treatment and correlate with efficacy in a pilot study combining everolimus with RT for NELM.

Materials and Methods: Fourteen patients with oligoprogressive (<4) NELM received everolimus (up to a max of 7.5mg daily) for 28 days prior to, concurrent with, and 14 days following RT. All patients received external-beam RT (30Gy in 10 fractions) or SBRT (up to 60Gy in 3-5 fractions over one to two weeks), with the preference for SBRT. Each patient had a DCE-CT and -MRI at baseline (t0), prior to RT (t1) and seven days after RT (t2). Per lesion response was evaluated by RECIST v1.1. Perfusion parameters of blood flow (BF) and blood volume (BV) by DCE-CT, and the volume transfer constant (Ktrans) and extravascular extracellular space (V_e) by DCE-MRI were correlated with the change in size of NELM at the 12-month follow-up (12mo). NELM not treated with RT served as internal controls. Statistics were performed using Wilcoxon Signed-Rank Test and Spearman's coefficient.

Results: Twenty-one and 14 treated NELM were evaluable by DCE-CT and -MRI respectively. Compared to t0, BV by DCE-CT increased at t1 by 11% (-15, +37%) (median (quartiles), then

significantly decreased after RT from t1 to t2 by -20% (-37, +2%) with p<0.01. Compared to t0, BF by DCE-CT decreased at t1 by -7% (-25, +33%) and decreased further after RT from t1 to t2 by -13% (-25, +25%) with p=0.35. Trend of increased BV in internal controls at each time point supports that the effect seen is due to RT. Compared to t1, the decrease in BV by DCE-CT after RT correlated with the max % change in the size of the treated NELM at 12mo (rs=-0.45, p=0.04). V_e by DCE-MRI increased between t0 and t1 from 0.25 (0.21, 0.35) to 0.32 (0.21, 0.42), p=0.59 and dropped after RT between t1 to t2 to 0.28 (0.21, 0.32) with p=0.02, whereas V_e continued to increase in untreated control data. A similar trend was observed for Ktrans. Conventional ORR was 33%; no progression was seen within 12mo. Twenty-one and 14 treated NELM were evaluable by DCE-CT and -MRI respectively. Compared to t0, BV by DCE-CT increased at t1 by 11% (-15, +37%) (median (quartiles)), then significantly decreased after RT from t1 to t2 by -20% (-37, +2%) with p<0.01. Compared to t0, BF by DCE-CT decreased at t1 by -7% (-25, +33%) and decreased further after RT from t1 to t2 by -13% (-25, +25%) with p=0.35. Trend of increased BV in internal controls at each time point supports that the effect seen is due to RT. Compared to t1, the decrease in BV by DCE-CT after RT correlated with the max % change in the size of the treated NELM at 12mo (rs=-0.45, p=0.04). V_e by DCE-MRI increased between t0 and t1 from 0.25 (0.21, 0.35) to 0.32 (0.21, 0.42), p=0.59 and dropped after RT between t1 to t2 to 0.28 (0.21, 0.32) with p=0.02, whereas V_e continued to increase in untreated control data. A similar trend was observed for Ktrans. Conventional ORR was 33%; no progression was seen within 12mo.

Conclusions: Changes in DCE-CT and -MRI are observed in patients receiving everolimus and everolimus+RT for NELM, with BV and v_e decreasing significantly post-RT. Given the challenges in assessing response in NELM using traditional RECIST in any context, DCE-CT and -MRI appear to be promising modalities; further studies are required.

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EVALUATION OF IMMOBILIZATION TECHNIQUES IN STEREOTACTIC BODY RADIOTHERAPY FOR EARLY STAGE LUNG CANCERS AND LUNG METASTASES

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Purpose: Stereotactic body radiotherapy (SBRT) for early stage lung cancers and small lung metastases has become the standard of care at many centres, with over 700 patients treated to date at the Cross Cancer Institute. Patients have traditionally been immobilized in a custom vac-fix bag supporting the arms and neck in a position of relative comfort as treatments may require up to 30 minutes. These immobilization devices are difficult for simulator therapists to construct in a manner that is reproducible across our department, and we have experienced a recent decline in the quality of vac-bags being produced. However, changes in treatment techniques over time, from 10-field conformal to volumetric arc therapies and the use of 10FFF beams have reduced treatment times immensely. Familiarity with set-up, imaging and tumour matching amongst radiation therapists has also led to shortened duration that the patient must remain in position. As such, we believe that SBRT lung patients can be treated using standard thoracic radiotherapy positioning devices, the same as are used for breast and long-course lung cancer treatments without an increase in intrafraction motion.

Materials and Methods: Immobilization techniques were evaluated for ease of use, restriction of intrafraction motion and problems with gantry collision with the positioning device or the patients' arms in a small group of 32 patients. The devices evaluated were our existing vac-fix bag technique, a new vac-fix bag technique to increase stability and reproducibility of the patients' arm position, and the standard AIO® board device with either the low or high arm rests. Intrafraction motion was measured by matching post-treatment cone-beam CT (CBCT) images and calculating a vector sum of total motion that had occurred since pre-treatment imaging.

Results: The vac-fix bags supporting the arms using our traditional or improved construction techniques resulted in an average vector sum of 0.29cm and 0.26cm, respectively, of intrafraction motion, with ranges of 0.04-0.76 cm and 0.03 to 1.02 cm. The new vac-fix bag technique was more stable on the treatment couch, but also led to more close encounters with the gantry and patients' elbows due to its increased height. The AIO® board with the low arm rest showed intrafraction motion of 0.23cm (0.02-0.63), so was not inferior to the custom vac-fix immobilization.

Conclusions: Despite alterations to our technique of producing the custom vac-fix immobilization, we did not see significant improvement in intrafraction motion. Changing to a standard thoracic RT positioning device did not result in increased motion and was appropriate for most patients. However, not all patients have the shoulder mobility to be able to use the low arm rest, and so the high arm rest is currently being evaluated to ensure that it does not result in more gantry/arm collisions. In the meantime, we are changing our processes to allow use of standard positioning when appropriate.

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SABR FOR THE TREATMENT OF OLIGOMETASTATIC CANCER – A HEALTH TECHNOLOGY ASSESSMENT

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Purpose: Oligometastatic cancer represents an intermediate state between cancer confined to a single location in the body and cancer that has metastasized widely. One treatment option, for which there is growing interest, is stereotactic ablative radiotherapy (SABR). The purpose of CADTH's Clinical Review was to evaluate the evidence on the clinical effectiveness and safety of SABR with or without standard of care (SOC) for patients with oligometastatic cancer.

Materials and Methods: CADTH conducted a systematic review of primary studies comparing the clinical effectiveness and safety of SABR plus or minus SOC to SOC alone for patients with oligometastatic cancer. Primary outcomes of interest were overall survival, progression-free survival, and adverse events. Additional outcomes of interest included freedom from progression, health-related quality of life, lesional control, and systemic therapy use after treatment.

Because the evidence on SABR for oligometastatic cancer is rapidly evolving, CADTH decided on a "living systematic review" format for the Clinical Review. This means that its status will be updated every three months to ensure that the findings reflect the latest up-to-date evidence on the topic.

Results: A total of 2859 citations were retrieved in the literature search, with eight additional potentially relevant reports retrieved from other sources. Ultimately, nine studies met the inclusion criteria for this review: three randomized controlled trials and six non-randomized studies. Types of primary tumours included breast, lung, kidney, colorectal, prostate, sarcoma, and other (non-specified). The number of metastases ranged from one to five, and metastatic sites included bone, lymph nodes, soft tissue, brain, nasopharynx, adrenal, lung, liver, and other.

The findings suggested that there may be overall survival and

progression-free survival benefits associated with SABR plus SOC compared to SOC alone. However, the findings from the studies comparing SABR alone to SOC were mixed and deemed inconclusive. With regards to adverse events, it is unclear whether SABR with or without SOC is more or less harmful than SOC alone. There was a lack of literature identified to inform conclusions for other outcomes of interest.

Conclusions: The current clinical evidence suggests that SABR plus SOC may offer survival benefits for patients with oligometastatic cancer. To inform patient selection criteria, future research on the effectiveness of SABR in patients with different characteristics would clarify who might benefit most from this treatment. Evidence on the optimal regimen or dose of SABR for the treatment of oligometastases is also needed.

Of note, this Clinical Review represents one component among many that decision-makers will consider when making the decision about the expanded use of SABR in Canada. CADTH is currently undertaking an Environmental Scan of implementation considerations that will further support decision-making.

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A REVIEW OF STEREOTACTIC ABLATIVE BODY RADIOTHERAPY OUTCOMES FOR EARLY STAGE NON-SMALL CELL LUNG CANCER AT THE NOVA SCOTIA CANCER CENTRE TO DETERMINE THE ROLE OF [18F] PET METRICS ON THE PREDICTION OF LOCAL FAILURE

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Purpose: To determine the overall survival (OS), local control (LC), and rates of distant metastatic (DM) disease for patients with early-stage non-small cell lung cancer (NSCLC) treated with SABR at the Nova Scotia Centre. To determine whether PET measures (i.e., Total Lesion Glycolysis, Metabolic Tumour Volume) from pre and six-month post-treatment PET are associated with clinical outcomes (i.e., local failure, overall survival, and distant metastasis).

Materials and Methods: Retrospective review of early-stage NSCLC (i.e., T1-2 N0 M0) treated with SABR from April 2013 to June 2015. Inclusion criteria included ECOG 0-2, maximum tumour diameter 5cm, pre- and six-month post-treatment [^{18}F] PET/CT. Patients were excluded if evidence of metastatic disease at diagnosis, prior radiotherapy to thorax, and T stage >2. We controlled for functional status, pre-treatment spirometry, histology, dose/ fractionation, age, sex, and PET/CT metrics (i.e., total lesion glycolysis (TLG), metabolic tumour volume (MTV), SUVMax, SUVAverage, and delta SUVMax/Average). Analysis consisted of Cox-proportional regression analysis for univariate and multivariate models, and Kaplan-Meier method survival analysis with consideration of competing risks.

Results: Eighty-seven patients met study criteria. Sixty-five cases were biopsy proven. Median follow-up 3.04 years. Mean age 75 years, 62% ECOG 0-1, 82% were treated with 48Gy in 4 fractions, and 69% were T1a-c. Local control was 83% at three years. Median OS was 49.3 months. Multivariate analysis demonstrated that TLG was predictive of local failure and overall survival for both the biopsy proven group and all comers. No significant associations were found with the other clinical outcomes and the evaluated [^{18}F] PET metrics.
8.6.1

Conclusions: Preliminary analysis has demonstrated OS within the expected parameters for early-stage NSCLC treated with SABR. Similarly, our three-year local control was 83% which is within the published parameters. We have determined that total lesion glycolysis is significantly associated with local failure and poorer overall survival. Further study of these associations are warranted.
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UTILIZATION TRENDS OF STEREOTACTIC RADIOSURGERY AND WHOLE BRAIN RADIOTHERAPY IN THE MANAGEMENT OF BRAIN METASTASES AT A REGIONAL CANCER CENTRE

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Purpose: Radiotherapy is the standard of care for the treatment of brain metastases. This can be achieved using either whole brain radiotherapy (WBRT), or stereotactic radiosurgery (SRS). Cranial radiation can be associated with significant neurocognitive sequelae, but this is minimized with the use of SRS, without survival loss. This have led to increased use of SRS in the treatment of brain metastases over the last several years. We set out to examine the use of both treatment modalities at a single institution over the last seven years.

Materials and Methods: We identified all patients treated for brain metastases at our institution from 2013 to 2020. Linear logistic regression analysis was used to assess trends in the use of SRS and WBRT over time. An odds ratio (OR) was calculated to demonstrate whether the likelihood of receiving SRS changed per year. A p-value <0.05 was considered significant.

Results: From 2013 to 2020, 2291 patients were treated for brain metastases. Of these, 59% were female and 41% were male. Fifty-six percent had lung cancer, 17% had breast cancer, 8% had melanoma and 19% had other primaries. Across all patients, there was significantly increased use of SRS from 2013 to 2020 with an OR of 1.44 (95% CI 1.38 – 1.51, p-value<0.0001). The utilization also varied significantly with primary, with adjusted OR of 0.52 for lung (p-value 0.047) and of 0.56 for breast (p-value 0.0003).

Conclusions: The use of SRS in the management of brain metastases at our institution increased from 2013 to 2020, in concordance with literature. The utilization of SRS varies across primaries. Patients with breast and lung primaries are approximately half as likely to be treated with SRS, compared to other primaries. Radiation programs should account for increased SRS use when procuring new equipment, developing QA programs and upgrading skills.

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SURVIVAL OUTCOMES IN PRIMARY ANGIOSARCOMA OF THE HEAD AND NECK: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Purpose: Angiosarcoma of the head and neck (ASHN) is a rare entity and confers substantial morbidity and mortality. Yet, the optimal management of ASHN remains unclear. This study aimed to describe the epidemiology of ASHN and to identify the most favourable treatment approach.

Materials and Methods: We performed a systematic review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, using the PubMed (Medline), EMBASE, and Cochrane Library databases, queried from 1990 until present. Articles in the English language reporting on survival outcomes of adult primary ASHN treated with curative-intent, were included. All estimates were weighted based on sample

size. Analysis of variance (ANOVA) and two-sample t-tests were used as appropriate. This study was registered with PROSPERO, CRD42021220970.

Results: A total of 3652 studies were identified, with 14 articles reporting on 2265 ASHN patients, meeting inclusion criteria. Mean ± SD age was 70.6 ± 7.7 years with 1621 (66.6%) men and 812 (33.4%) women. ASHN involved the scalp (n=176, 57.9%) and the face (n=128, 42.1%). Two hundred forty-nine patients had early Stage I-II disease (39.6%) whereas 379 had late Stage III-IV disease (60.4%). Most (n=529, 45.6%) received surgery and radiotherapy (RT), 305 (26.3%) received surgery alone, 210 (18.1%) received definitive RT/chemoradiotherapy (CRT), 75 (6.5%) received surgery and CRT, and 33 (2.8%) received surgery and chemotherapy. Negative margins were achieved in 471 (55.9%) whereas 371 (44.1%) had positive margins. Mean ± SD follow-up was 41.7 ± 15.4 months. Weighted mean, one-, five-, and 10-year overall survival (OS) were 26.9 months, 67.3%, 30.6%, and 20.8% respectively. Mean and five-year disease-specific survival (DSS) were 72.9 months and 50.3% respectively. Mean ± SD local recurrence rate (LRR) was 32.1 ± 11.7%. Median RT dose delivered was 60Gy (interquartile range: 60-70). Patients who received surgery had a significantly higher mean OS (34.9 versus 18.7 months, p=0.04) and five-year OS (30.1 versus 14.2%, p=0.01) compared with those who did not receive surgery. There was no significant difference in mean OS for receiving adjuvant chemotherapy (p=0.99) or RT (p=0.51).

Conclusions: In the largest ASHN study to date, definitive surgical resection was associated with an improvement in OS. Multimodality treatment did not confer an OS benefit. Randomized trials are needed to establish the optimal treatment approach for ASHN.

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REAL-WORLD OUTCOMES OF CHEMORADIATION AND CONSOLIDATIVE DURVALUMAB IN UNRESECTABLE STAGE III NON-SMALL-CELL LUNG CANCER – A SYSTEMATIC REVIEW

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Purpose: The PACIFIC study was a randomized control trial that demonstrated an overall survival (OS) and progression-free survival (PFS) advantage with the use of consolidative Durvalumab following chemoradiation (CRT) in patients with unresectable Stage III non-small cell lung cancer (NSCLC). However, its benefit in real-world practice is only emerging. We conducted a systematic review of the literature to determine the real-world evidence to date with respect to outcomes and side effects of consolidative durvalumab following CRT.

Materials and Methods: A systematic review was conducted using PRISMA guidelines. We searched Embase and Ovid MEDLINE databases for studies in English that included the keywords "durvalumab", "NSCLC", and "Stage III" from inception to December 2020. The resultant search was screened and abstracted for primary studies that disclosed OS, PFS and/or local control, and adverse events with consolidative durvalumab following CRT. These real-world studies (both published and in abstract form) were reviewed and compared with the outcomes of the PACIFIC clinical trial.

Results: A total of 691 studies were identified from the initial database search. Applying inclusion and exclusion criteria, nine real-world studies reported outcomes of applying consolidative durvalumab after CRT. All studies were published between 2018 and 2020. The median number of patients was 29 (range 16-147). The median follow-up was 7-17 months. Reported one-year OS and PFS ranged from 77-94% and 56-65% respectively, compared to 83% and 56% in the PACIFIC study. Median OS was not reached in all real-world studies, and few studies reached median PFS (22%). Local-regional control (~86% at one year) and time to metastasis or death (67-70% at one year) were inconsistently reported. Adverse events, especially pneumonitis (12-25%), led to discontinuation of durvalumab in 19-36% of patients across the studies, compared to 15% reported in the PACIFIC trial.

Conclusions: Real-world studies on the use of consolidative durvalumab in Stage III NSCLC appear to confirm the OS and PFS advantages reported by the PACIFIC study. Toxicity, including pneumonitis appeared slightly higher than in the PACIFIC trial; the implication of current radiation dose-volume lung parameters in context of consolidative durvalumab will be important for future risk mitigation. Median follow-up was short on average, and updated results with longer follow-up will be important to confirm the clinical efficacy of durvalumab and its safe use in clinical practice.

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RADIATION THERAPY MANAGEMENT FOR METASTATIC DISEASE TO THE BRAIN IN NSCLC PATIENTS – SURVIVAL OUTCOMES OF THE BC CANCER REGISTRY 1996-2016

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Purpose: Radiation therapy (RT) for brain metastases in patients with non-small cell lung cancer (NSCLC) has undergone considerable evolution but remains controversial. We analyze patient and treatment characteristics for prognostic value in a large cohort.

Materials and Methods: Records for 2212 patients with NSCLC who received RT to the brain at one of six locations between 1996-2016 were retrospectively analyzed. Data were obtained from the institutional cancer registry following research ethics board approval. Overall survival (OS) was calculated from diagnosis of lung cancer to death, and Kaplan-Meier curves were compared using Log-rank (univariate) and Cox proportional hazards regression (multivariate).

Results: Median overall survival (OS) was 11.8 months (95% CI 11-12.6 months). Median age was 65, and 1254 patients (57%) were female. ECOG performance status at diagnosis was 0 (12%), one (31%), two (17%), three (14%), four (2%), and unknown (24%). Younger age (HR 0.99, 95% CI 0.98-0.99), female sex (HR 0.80, 95% CI 0.74-0.88), and better ECOG performance status (p<0.0001) were associated with superior OS in multivariate analysis. There was better OS in 932 patients (42%) that received systemic chemotherapy (HR 0.63, 95% CI 0.58-0.69) and 603 patients (27%) that underwent surgery (HR 0.55, 95% CI 0.50-0.61). 2004 patients (91%) received one RT course to the brain, while 208 patients (9%) received multiple courses in various combinations of whole brain RT (WBRT) and stereotactic radiosurgery (SRS). SRS (HR 0.70, 95% CI 0.57-0.86) and multiple RT courses to the brain (HR 0.55, 95% CI 0.46-0.65) were associated with better OS. Median time from lung cancer diagnosis to start of first brain RT was 2.5 months, and from end of first brain RT to death was 3.5 months. A longer lung cancer diagnosis to first brain RT interval was associated with better OS (HR 0.95, 95% CI 0.95-96).

Conclusions: NSCLC patients with brain metastases continue to face poor prognosis, particularly those patients with a short lung cancer diagnosis to start of brain RT interval. Our analysis revealed younger age, female sex, and better ECOG performance status as predictors of superior survival. SRS and multiple RT courses to the brain also revealed superior survival, understood to be the result of patient selection and hence interpreted with caution.

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FIVE-YEAR SURVIVAL, TOXICITY, AND PATIENT REPORTED QUALITY OF LIFE AFTER INTENSITY MODULATED RADIATION THERAPY-BASED CONCORRENT CHEMORADIOTHERAPY FOR LOCALLY ADVANCED ANAL CANCER

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Purpose: Locally advanced anal cancer is effectively treated with sphincter-sparing concurrent chemoradiation (CCRT). Quality of life (QOL) evaluation has become an important outcome measure in patients with anal cancer since long-term survivorship of patients has increased with the advent of Intensity Modulated Radiation Therapy (IMRT)-based CCRT. The influence of IMRT on long-term QOL for patients with anal cancer is poorly documented. The aims of this study were to prospectively evaluate the long-term patient-reported QOL and toxicity after IMRT-based CCRT in locally advanced anal cancer, and explore the predictors that influence QOL in this patient population.

Materials and Methods: Fifty-seven patients treated with CCRT consisting of IMRT and concurrent 5-fluorouracil/mitomycin-C underwent QOL evaluation with the EORTC core (QLQ-C30) and colorectal (QLQ-CR29) questionnaires. QOL questionnaires were collected at baseline, during treatment, and every 6 months follow-up until 60 months. The QOL scores at baseline and at the 60-month mark were compared by calculating mean scores and paired difference based on recommendations by Osoba *et al*. (1998) and Cocks *et al.* (2012).

Results: The median follow-up was 98 months. The five-year recurrence-free survival (RFS), overall survival (OS), and cancer-specific survival (CSS) were 71%, 80%, and 83%, respectively. Forty-four patients were evaluable for long-term QOL analysis. The compliance rate for completion of the QLQ-C30 questionnaires was 88.6% at six months, and 65.7% at 60 months. At 60 months, the mean scores of global health status, all the functional scales, and all symptoms except diarrhea were improved indicating normalization of QOL. The mean score difference was clinically and statistically significant for global health status (p=0.003), emotional functioning (0.0017), and social functioning (0.0001), with improvement at 60 months. The evaluation of QLQ-CR29 questionnaire showed moderate worsening of urinary incontinence (p=0.0045). There was clinically and statistically significant improvement in blood and mucus in stool (p=0.0018), buttock pain (p<0.0001), and anxiety (p=0.001). There was moderate deterioration in dyspareunia (p=0.103) and sexual interest (p=0.548).

Conclusions: The findings of this study support the routine use of IMRT-based chemoradiation for locally advanced anal cancer from a cancer outcome and long-term QOL perspective. However, patients experienced deterioration in GU functioning domains, including sexual function, thus awareness and education for both physicians and patients is warranted, to ensure appropriate counselling and management. Further larger scale studies are warranted.

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YOUNGER PATIENTS WITH SCC OF THE HEAD AND NECK – EXAMINING A CHALLENGING HEAD AND NECK POPULATION, AN ANALYSIS OF THE BC CANCER REGISTRY 2007-2017

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Purpose: Younger patients with squamous cell carcinoma (SCC) of the head and neck represent a small but potentially growing demographic with unique clinical challenges. We analyzed a large cohort of patients (35 to ≤50 years old) originating from the BC Cancer registry.

Materials and Methods: Head and neck SCC cases C00-C40 (ICD10) diagnosed 2007-2017 were selected, KM survival analysis was carried with respect to age, gender, histology, staging and management.

Results: Five hundred ten patients (123(24%) female, 387(75%) male), median age 47 (range 35-50) were included. Subsite distribution: oropharynx (OPX) 266 (55%), oral cavity (OC) 98 (20%), larynx (LX) 53(11%), nasopharynx (NPX) 52 (11%), hypopharynx (HPX) 18 (4%), other 23(5%). One hundred seventy-four (34%) of the cohort was ≤45 years of age. Stage IV disease was the most common stage at diagnosis in OPX (193(73%), OC 37 (38%) and NPX 19 (37%). 503 pts received RT, 485 (96%) with radical intent, median dose 70Gy (range 28-74 Gy), (392 (78%) definitive and 93(18%) adjuvant), 18 (4%) palliative intent. Median overall survival (OS) overall was 49 months, OPX (52 months), NPX (52 months), LX (45 months), OC (35 months). Three hundred fifty-eight (70%) of patients were alive at the time of the analysis across all sites except OC where only 49% were alive. There was no statistically significant difference in OS by gender or clinical stage with the exception of LX where early stage was prognostic for superior OS. OC exhibited the poorest outcomes with only 50% of the cohort alive at 50 months.

Conclusions: OPX followed by OC were the most common subsites encountered in younger patients with OC exhibiting an exceedingly poor prognosis (median OS 35 months). Most patients were diagnosed with Stage IV disease emphasizing the need for earlier diagnosis and education about the symptoms and risk factors.

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RETROSPECTIVE CHART REVIEW OF STAGE 3 NON-SMALL CELL LUNG CANCER CASES IN THE WINDSOR REGIONAL CANCER CENTRE FROM 2008 TO 2015

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Purpose: Lung cancer is one of the most commonly diagnosed malignancies in Canada and remains the leading cause of cancer death. In Canada non-small cell lung cancer (NSCLC) accounted for approximately 88% of lung cancer diagnoses from 2012-2016. Poor survival may in part be influenced by frequent late stage diagnosis, with 20% of lung cancers being diagnosed at Stage 3 with a three-year predicted net survival of 22%. Survival for Stage 3 NSCLC with concurrent chemo radiation ranges from 10 to 34% at three years and 9 to 16% at five years. The purpose of the chart review is to assess patient outcomes for those diagnosed with Stage 3 NSCLC at the Windsor Regional Hospital and evaluate potential factors that influenced survival and recurrence.

Materials and Methods: A retrospective chart review of patients clinically diagnosed with Stage 3 NSCLC at the Windsor Regional Cancer Centre from 2008 to 2015 was conducted. For the 253 patients identified (38.3% female, 61.7% male) information on patient characteristics, tumour factors and treatment received was collected. Treatment was categorized into no treatment, standard treatment that included chemotherapy and radical radiation, and non-standard treatment encompassing all other treatments.

Results: The patient population age range was 39 to 88 years, with a median age of 68 years. The primary tumour location was in either the right or left upper lobe in 64.7% of patients. Three-year survival considering all-cause mortality was 20.75% for the entire patient group. Comparing treatment groups, the three-year survival for patients who received no treatment, non-standard treatment and standard treatment was 9.68% (95% CI 2.47, 22.91), 9.51% (95% CI 5.22, 15.34) and 41.09% (95% CI 30.78, 51.10) respectively. 8.7% of all patients had no recurrence of their original lung cancer five years post-diagnosis.

Conclusions: In conclusion, we found overall three-year survival of all Stage 3 NSCLC patients treated at the Windsor Regional Cancer Centre to be comparable to the national survival for lung cancer patients. There were differences between treatment groups with standard chemo radiation treatment having a higher three-year survival compared to other treatment groups and compared to previous literature.

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LONG-TERM SURVIVAL OF PATIENTS WITH RECURRENT RECTAL CANCER IS POSSIBLE

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Purpose: The combined modalities with radiotherapy, chemotherapy, and surgery have been proved to be an important component of treatments for locally advanced rectal cancer including Stage II and Stage III in terms of decreased local recurrence and increased overall survival in addition to surgical resection. This study was conducted to analyze the recurrence/survival of a contort of patients.

Materials and Methods: A cohort of consecutive patients is retrospectively studied. Patients received either neoadjuvant or adjuvant treatment. The long-course chemoradiotherapy was typically in two phases with 45Gy in 25 fractions to the pelvis followed by 5.4Gy in 3 fractions boost. The concomitant chemotherapy was either infusional 5-FU or oral Capecitabine. Some patients were treated with short- course neoadjuvant radiotherapy alone with 25Gy in 5 fractions.

Results: A total of 364 patients are identified, male 235, age 28-90 years old, median 62; female 129, age 35-89 years old, median 63. There are 83 patients (22.8%) who had recurrence. Among those, 26 patients (31.33%) had pelvic local recurrences and 8 out of these 26 patients (30.77%) also developed distant metastases in the same time. Out of these 26 patients, 16 patients (61.54%) had recurrence in the pre-sacral space alone or with other sites of recurrence while 13 patients (50.00%) developed recurrence at the anastomosis and perineal recurrence were found in two patients (7.69%). The remaining 57 patients (68.67%) developed distant metastases without local failure. Pulmonary metastases were the highest with 32 out of 83 patients (38.55%) while hepatic metastases were the second most common ones with 29 out of 83 patients (34.94%). The median time for pulmonary recurrence is 15 months (3-72 months) while the median time for liver metastases is 11 months (1-34 months). The median time for local recurrence is 17 months (3-51 months). There were three patients who had isolated local recurrence and who have survived eight to 11 years without evidence of further recurrence. There were five patients with hepatic and or pulmonary metastases who are still alive without evidence of further recurrence 7 to 14 years after treatments for recurrence.

Conclusions: The recurrence includes local and distant. The most common site of local recurrence is pre-sacral space and the second common local recurrence is at the anastomosis. The most common distant metastatic site is the lungs and the liver are the second most common site. Some of the patients with either local recurrence or distant metastases at the lung or liver are potentially curable. It is possible to salvage the isolated local recurrence and insignificant pulmonary or hepatic metastases with the possibility for cure though most of the treatment failures were not salvageable.

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FATIGUE AS A COMPLICATING FACTOR IN THE RECOVERY OF BREAST CANCER SURVIVORS TREATED AT AN ONCOLOGY CLINIC IN SOUTH WEST NIGERIA

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Purpose: Recovering cancer survivors hope to return to their premorbid lifestyle after treatment and being free from disease. They are however faced with some psycho-social issues including post-treatment fatigue which could be distressing and negatively impact their quality of life. Fatigue could have economic impact, as it may reduce their ability to work after being disease-free. It is important to explore fatigue in these group of patients with a view to find ways of reducing it to the barest minimum. This study aims to assess fatigue in breast cancer survivors on follow up visit at radiation oncology clinic and compare it with age-matched apparently healthy controls.

Materials and Methods: This is a case-control study. Fatigue levels were obtained using the Fatigue Symptom Inventory (FSI). Kruskal-Wallis H tests was used to compare FSI score in cases and controls. Chi-square test was used for comparison of proportion. Level of significance was set at 5%.

Results: One hundred and forty patients were recruited. Seventy were cancer survivors (cases) and seventy were apparently healthy age (±1) matched controls. They were all females with mean age 51 years. Significant fatigue was reported among cases than controls (24.3 % versus 10%; p=0.025). Subjects with breast cancer reported significantly worse fatigue on the day they were most fatigued (p=0.017), least fatigued (0.047) and fatigued on the average (p=0.006) compared to controls. Fatigue also significantly interfere with the ability to concentrate (p=0.040) and relate with people (p=0.002) more in cases compared to controls. While fatigue was commoner in the morning and afternoon in breast cancer survivors, fatigue either occur more in the evening or follow no daily pattern in the controls.

Conclusions: Breast cancer survivors reported worse fatigue than the controls. This suggests the need to include fatigue screening as part of assessment when patients present for follow-up. There is also a need to investigate the factors responsible for this and explore ways of reducing or eliminating it.

Corrections to 2020 Green Journal

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CONVENTIONAL AND MACHINE LEARNING ANALYSES TO DIFFERENTIATE SYSTEMATIC VERSUS RANDOM INTER-FRACTIONAL CHANGES IN A COHORT OF 250 HEAD AND NECK CANCER PATIENTS

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Purpose: Given the close proximity of target volumes and organs at risk (OAR) in the head and neck, it is important to ensure that delivered doses achieve the same accuracy as planned doses. However, systematic inter-fractional anatomical changes, such as tumour shrinkage and weight loss, may affect plan accuracy differently than random setup uncertainties. To assess these differences, we measured anatomical changes using on-unit cone beam computed tomography (CBCT) imaging and compared these with changes in delivered dose.

Materials and Methods: Two hundred-fifty H&N cancer patients treated with curative-intent chemo-radiotherapy (70Gy in 33 fractions) were retrospectively analyzed. We acquired five CBCT measures per patient from their last recorded CBCT scans (approximate fraction 30), including changes in: face diameter, neck diameter, chin position, shoulder position, and head position. Delivered doses were estimated for OARs (pharyngeal constrictor, brainstem, parotid and submandibular glands) and tumour volumes. We used conventional statistical analyses to assess correlations among anatomical and dosimetric changes (Kendall's tau correlation tests, MANOVA, and Mann-Whitney U test). In addition, K-medoid clustering and principal components analysis (PCA) indicated which patients had systematic inter-fractional changes versus random setup uncertainties.

Results: Correlation and clustering/PCA analyses revealed that systematic weight loss effects (i.e., changes in BMI, face diameter, and neck diameter) were positively correlated with increases in dose to central-axis OAR (spinal cord and pharyngeal constrictor). Data clustering indicated that 30.4% of patients exhibited systematic anatomical changes. Systematic anatomical changes were significantly associated with increases in brainstem and spinal cord dose (MANOVA: $p<0.05$) and multiple CT measures correlated with increases pharyngeal constrictor dose (Mann-Whitney U tests: $p<0.05$). Losses in target coverage were not correlated with systematic changes in anatomy.

Conclusions: On-unit CBCT measurements appear to be able to differentiate systematic inter-fractional changes from random daily variations. Measurements, such as change in BMI, face diameter, and neck diameter, may be used to identify patients with increases in delivered dose to the brainstem, spinal cord, and pharyngeal constrictor.

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PUTTING THE "QUALITY' IN 'QUALITY-BASED PROCEDURES": DRIVING QUALITY OF CARE FOR PATIENTS THROUGH THE DEVELOPMENT OF A PROVINCIAL RADIATION TREATMENT FUNDING MODEL

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Purpose: Quality-based Procedures (QBP) offer opportunities for healthcare providers to share best practices to promote, through a QBP-linked funding model, quality of care including system efficiencies. Utilization of best practices is intended to provide standardization of care by reducing inappropriate/ unexplained variation and ensuring patients get the right care at the right place and time. In 2018, the Ontario Ministry of Health requested that Cancer Care Ontario develop a Radiation Services QBP. The objective of this abstract is to share the creation and application of quality metrics (QMs) to corresponding radiation protocols from the QBP process to inform standardization, best practices, safety, and quality of care.

Materials and Methods: Over an 18-month period, the RT Program at Cancer Care Ontario collaborated with 14 cancer centres (200+ multidisciplinary clinicians) to develop 254 protocols and 761 QMs across 14 disease site groups. This process began with a preliminary environmental scan of local, national and international guidance documents. The resulting set of protocols and QMs were brought forward to clinical consensus meetings for review and input with 22 expert panels (129 clinicians), nine working groups (187 clinicians), and six advisory committee meetings.

Results: The QM development process provided a platform for knowledge translation and exchange (KTE). The 761 QMs were entered into a repository and categorized by disease site groups, sub-disease site, category, disease trajectory (pre-treatment, imaging and planning, treatment, quality assurance, follow-up), data holdings/source, and reporting (self-audit, data-driven, self-reporting).

Conclusions: Creation of the QMs in the QBP have been a successful KTE strategy for sharing clinical best practice. Next steps include utilizing the repository to identify disease-specific QMs and tie them to funding, thereby ensuring the delivery of safe and quality RT across the province (i.e. a breast protocol will not be reimbursed if a QM such as, need to minimize cardiac dose, is not adhered).

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